INSTRUCTION MANUAL

STABRO LABORATORIES, INC.
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TYPE RM 561 OSCILLOSCOPE

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

INSTRUCTION MANUAL

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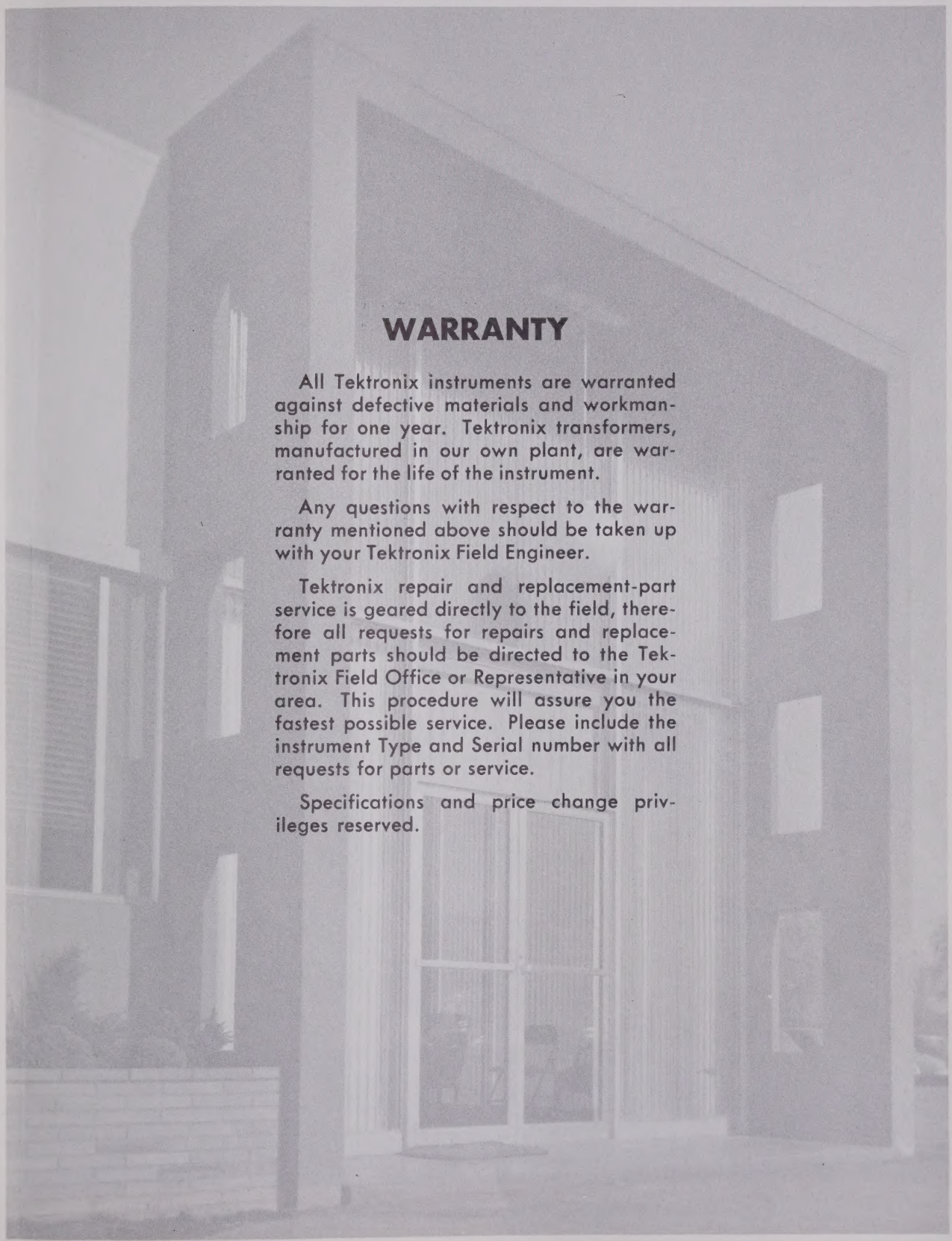


WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.

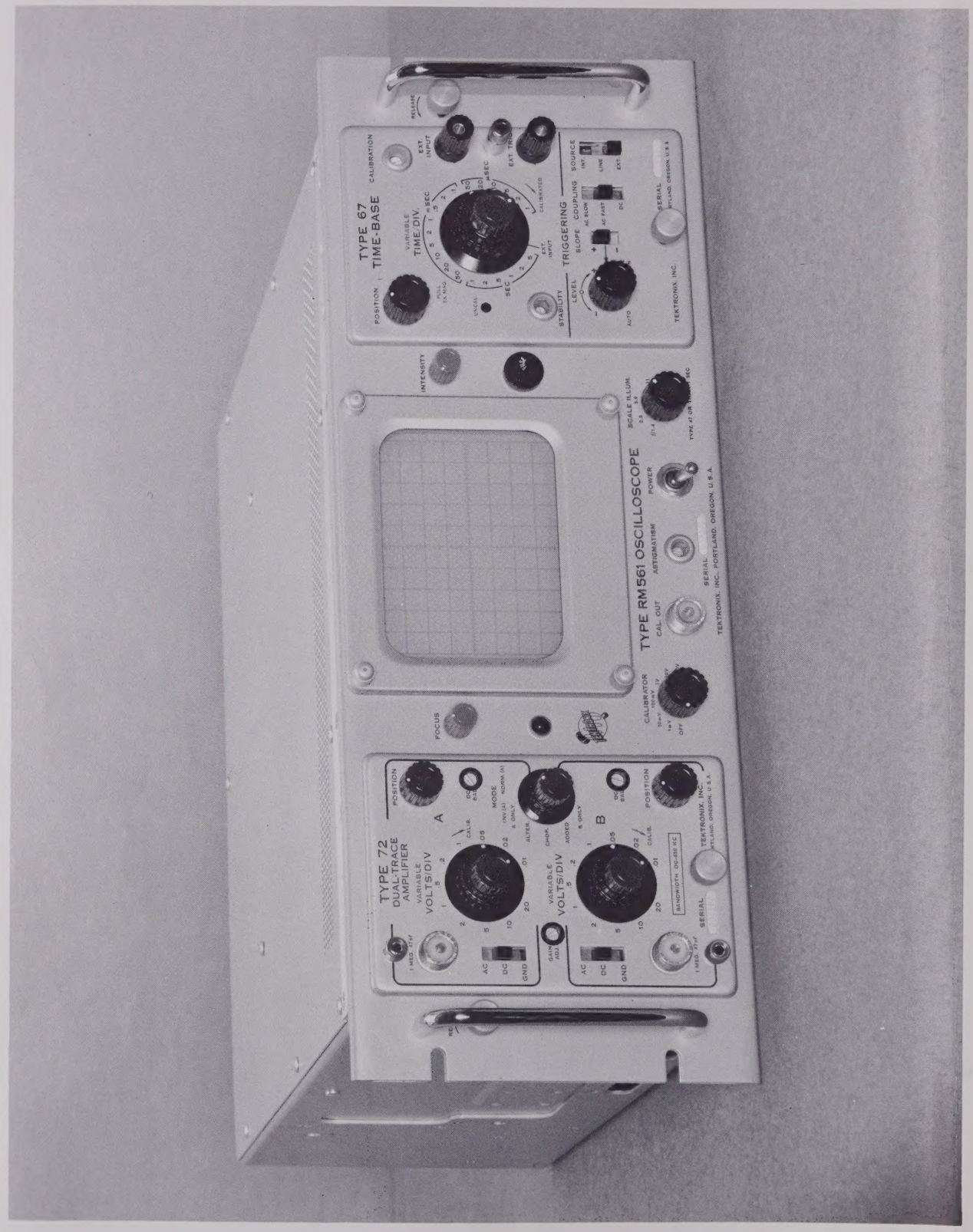


Fig. 1-1. Type RM561 Oscilloscope (with Type 72 Dual-Trace Amplifier and Type 67 Time-Base).

SECTION 1

GENERAL INFORMATION

INTRODUCTION

The Tektronix Type RM561 Oscilloscope, Fig. 1-1, consists of an Indicator Unit and any two of a number of available plug-in units. The Indicator Unit contains a power supply, a cathode-ray tube and associated circuitry, and a calibrator. The plug-in units take the place of the vertical and horizontal deflection systems in a conventional oscilloscope; their outputs connect directly to the deflection plates of the cathode-ray tube. The plug-in units can be selected to give the Type RM561 the degree and type of performance demanded of it by a particular application. Plug-in units presently available for use with the Type RM561 are described in the Accessories Section of this manual.

This section of the manual describes the operation and maintenance of the Type RM561 as a complete unit; that is, with plug-in units installed. Section 2 of this manual contains the circuit description, troubleshooting instructions, and calibration procedures for the Type RM561 only. Separate manuals are supplied with the individual plug-in units; these manuals have been punched to allow them to be inserted in the same binder with the Type RM561 manual.

A parts list and schematic diagrams are contained at the rear of each of the manuals.

CHARACTERISTICS

Cathode-Ray Tube

Type: T503RP2. Other phosphors optionally available.

Accelerating potential: 3500 volts.

Usable vertical viewing area: 8 divisions ($3\frac{1}{8}$ inches).

Usable horizontal viewing area: 10 divisions ($3\frac{15}{16}$ inches).

Deflection plate sensitivity (at 3500 volts);

Vertical: 23.2 volts per centimeter.

Horizontal: 18.7 volts per centimeter.

Calibrator Voltages

Amplitude: 1 millivolt to 100 volts (peak-to-peak) in six fixed steps.

Accuracy: 3%.

Waveshape: Square wave at line frequency.

Risetime: Typically 4 microseconds.

Ventilation

Forced air.

Finish

Photo-etched, anodized front panel.

Dimensions

Height: 7 inches.

Width: 19 inches.

Rack Depth: 18 inches.

Weight

31 pounds, net.

Power Requirements

See Preliminary Information.

PRELIMINARY INFORMATION

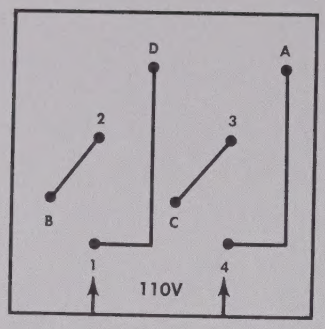
Power Requirements

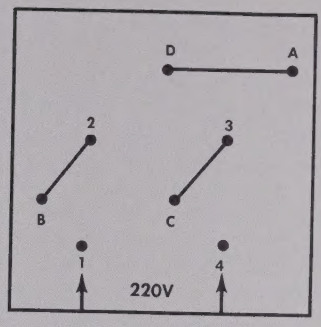
The line transformer in the Type RM561 is wired for either 117-volt or 234-volt operation; a plate on the rear of the instrument specifies the voltage for which your instrument is wired. If the instrument is wired for 117-volt operation, it will operate at any line voltage between 105 and 125 volts, at a frequency of 50-60 cycles. Line voltages beyond the specified limits may cause the power supplies to go out of regulation. A 3-amp slow-blowing fuse is required for 117-volt operation.

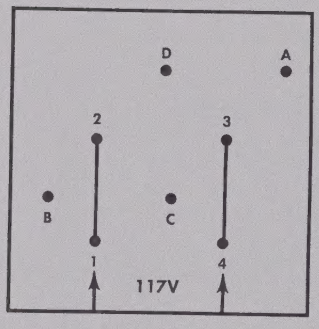
If desired, you can convert your Type RM561 from 117-volt operation to 234-volt operation, or vice versa, by changing the fan connections and the wiring on the line transformer, as shown in Fig. 1-2 (this information is also indicated on the rear panel of the instrument). If the instrument is wired for 234-volt operation, it will operate at any line voltage between 210 and 250 volts, at a frequency of 50-60 cycles. A 1.25-amp slow-blowing fuse is required for 234-volt operation.

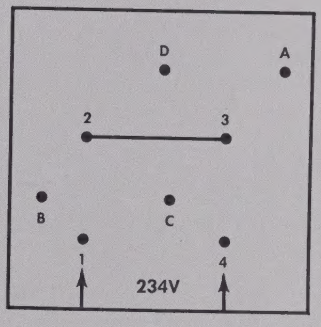
If the line voltage in your area is consistently high or low with respect to the foregoing nominal voltages, you should make use of the special auxiliary windings in the line transformer. These windings may be connected to either aid or oppose the primary winding. By connecting these windings in the circuit as shown in Fig. 1-2, the nominal operating voltage of the instrument can be raised or lowered by about 6%. This also raises or lowers the regulating range of the instrument the same amount.

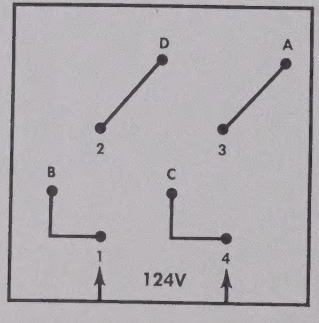
Power consumption of the Type RM561 (with Type 72 and Type 67 plug-in units inserted) is about 185 watts.

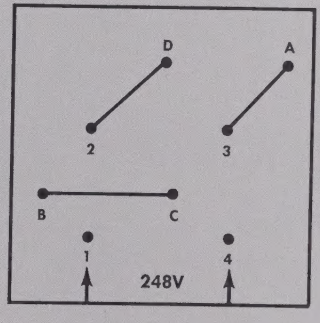


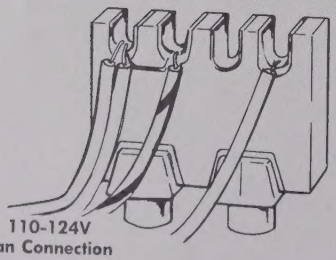












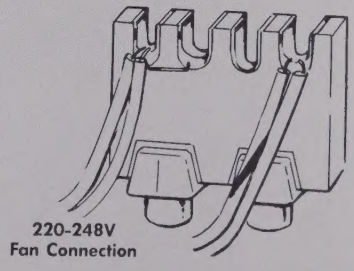


Fig. 1-2. Power transformer primary connections.

Cooling

The Type RM561 is forced-air cooled by a fan at the rear of the instrument. The fan pulls air from the front portion of the instrument and exhausts it through a screen on the rear panel. If desired, the flow of air may be reversed through the instrument. The fan has adequate lead length and snap-in type mounting for this purpose.

When you install the Type RM561 in a relay rack, make sure the air can circulate freely through the instrument. This will provide maximum heat dissipation from within the instrument. If, for some reason, the internal temperature of the Type RM561 goes above 123°F., a thermal cutout de-energizes the instrument. If your instrument is wired for 117-volt operation, the fan will continue to run after the thermal cutout actuates. The thermal cutout restores the power once the internal temperature returns to normal.

Reoiling of Muffin Fan

If the fan is sluggish in coming to speed, will not start without assistance, or takes more than 90 volts to start, reoiling may be effective in restoring it to use.

This can be done as follows:

1. If the Muffin has a paper label on the spider face, cut away a circular portion of the label about $\frac{1}{2}$" diameter, which will expose the rubber dust cap covering the bearing and shaft end. This may be pried out with the end of a knife or needle. Hold the fan with the shaft vertical and the prop down. Fill the space around the end of the shaft with SAE 10 or 3-in-1 oil, or use a good grade of light instrument oil such as Aeroshell fluid No. 12 or Esso P.38. Run the unit for as long as possible, without replacing the cap, in the same position. Oil should be absorbed after several hours. Fan speed should be at least 3050 rpm. Replace the cap and reinstall the unit.

2. After a long period of running or after running in excessively high ambient temperatures, a black, gummy substance may be formed from the oil. This can be cleaned out from the area around the end of the shaft with a lint-free cloth or absorbent paper.

3. If the amount of this black substance is too great to permit free running even after reoiling, the unit will have to be disassembled and cleaned. This is done by removing the two steel grip rings in the shallow groove at the end of the shaft.

After cleaning, reassemble the unit and reoil as in step 1.

Rack Mounting

The Type RM561 is ready for rack mounting in a standard 19 inch open or closed relay rack.

To mount the instrument directly to either type of rack, first select four screws from the hardware kit whose threads match those of the mounting rack. Align the slots at the sides of the front panel with the holes of the rack, at the desired height. Fasten the instrument to the rack using the four mounting screws, cup washers, and plastic washers. The plastic washers keep the front panel from being marred by the cup washers when the mounting screws are tightened down.

If desired, you may rack mount the instrument on slide-out tracks (Chassis-Traks). Chassis-Traks are described in the Accessories Section of this manual.

OPERATING INSTRUCTIONS

Operation of the Type RM561 Oscilloscope with plug-in units is much the same as that of a conventional Tektronix oscilloscope with corresponding vertical and horizontal deflection systems. Full operating instructions for the plug-in units are contained in the manuals which accompany them.

Any of the plug-in units may be inserted into either opening in the front of the instrument. The plug-in unit in the right-hand opening controls the horizontal deflection of the crt beam and the one in the left-hand opening controls the vertical deflection. Thus, it is possible to change from a horizontally timed sweep to a vertically timed sweep merely by changing the position of a time-base type plug-in. However, retrace blanking is provided for only in conventional operation. Consequently, when you use a vertical sweep, the retrace of the beam will be visible at fast sweep rates.

X-Y operation is obtained by using plug-in amplifiers in both oscilloscope openings. (The right-hand opening is often referred to in the plug-in manuals as the "X-axis" opening; the left-hand opening is referred to as the "Y-axis" opening.)

Intensity modulation of the crt beam is possible through the CRT GRID binding post on the rear of the instrument. A negative pulse of about 20 volts will cut off the beam from normal intensity.

To remove a plug-in from the oscilloscope, turn the aluminum knob at the bottom center of the plug-in several turns counterclockwise and pull. To insert a plug-in, push it all the way into the opening and turn the knob clockwise until it is tight. The oscilloscope will not be damaged by having the power applied with the plug-in units removed.

When you change a plug-in unit from one opening of the Indicator Unit to the other, you must adjust the gain of the plug-in to allow for the differences in horizontal and vertical deflection sensitivities of the crt. To adjust the gain of a plug-in unit, apply a known voltage (or in the case of a time-base plug-in, apply a signal whose time duration is known) to the amplifier plug-in. Then set the GAIN ADJ. or the CALIBRATION adjustment on the plug-in front panel for the proper deflection or sweep rate. See the plug-in instruction manual for detailed information about setting the gain.

Because of different average deflection-plate voltages produced by the various plug-in units, the basic crt sensitivity may change as plug-in units are changed. Therefore, it may be necessary to change the GAIN ADJ. or CALIBRATION adjustment on a given plug-in if the one in the other opening has been changed.

The ASTIG. (a front-panel screwdriver adjustment on the Indicator Unit) may require readjustment when the plug-in

units are changed. Details on the adjustment of the ASTIG. control may be found in the Calibration portion of Section 2 under "Crt Circuit".

REMOVAL AND REPLACEMENT OF PARTS

Procedures required for the replacement of most parts in the Type RM561 are obvious. Detailed instructions on their removal are therefore not required. Other parts, however, can best be removed if a definite procedure is followed. Instructions for the removal of some of these parts are contained in the following paragraphs. Parts-ordering information is included in the Parts List at the rear of this manual.

Replacement of the Cathode-Ray Tube

To remove the cathode-ray tube, disconnect the four leads connected to the neck of the tube. Remove the graticule cover, spacer washers, and graticule light shield. Loosen the tube clamp at the base of the crt. Disconnect the tube socket while pulling the crt straight out through the front panel. Be careful not to bend or break the crt neck pins on the tube shield as you remove the tube.

Install the new crt by the reverse of the above procedure. Follow the color-code information on the tube shield when you reconnect the leads to the crt neck pins.

After replacement of the the crt, it may be necessary to recalibrate certain portions of the oscilloscope. Special attention should be given to calibration of time-base and amplifier plug-in units.

Replacement of Ceramic Terminal Strips

To remove a ceramic terminal strip, unsolder all connections, then pry the strip, with yokes attached, out of the chassis (see Fig. 1-3). An alternative method is to use diagonal cutters and cut off one side of each yoke to free the strip, using care not to damage the spacer. After removing the strips, the remainder of each yoke can be easily removed from the chassis with a pair of pliers. The yokes need not be salvaged since new ones are furnished with each strip. However, the spacers may be reused at least two times before you need to order new ones. When ordering spacers, specify the mounting height of the sleeve desired: $^3/_{32}$", $^3/_{16}$", or $^3/_8$". When ordering the ceramic strips specify the number of notches and the correct height.

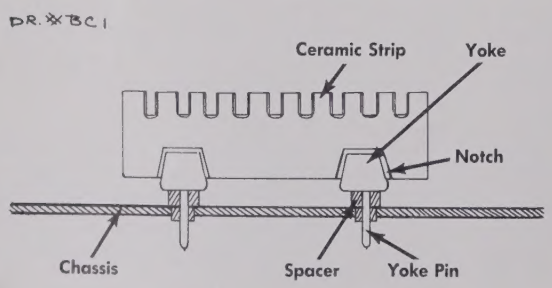


Fig. 1-3. Ceramic terminal strip installation.

When the old strip and yokes have been removed, insert the replacement parts into the spacer sleeves that are located in the holes of the chassis. If necessary, use a plastic or hard rubber mallet to seat the yokes firmly into the spacers.

Be sure to observe the soldering precautions described in the following paragraph when resoldering connections to the new strip.

Soldering Precautions

In the production of Tektronix instruments a special silver-bearing solder is used to establish a bond to the ceramic terminal strips. This bond can be broken by repeated use of ordinary tin-lead solder or by the application of too much heat. For this reason, we recommend the use of a wedge-shaped soldering-iron tip, and solder containing about 3% silver for installing or removing connections from the strips. The silver-bearing solder is locally available in most areas, or it may be purchased directly from Tektronix in one-pound rolls (order by part number 251-514). Occasional use of ordinary solder will not break the bond, however, if too much heat is not applied.

TROUBLESHOOTING

This portion of the manual is intended to enable you to isolate trouble in the instrument to the plug-in units or to the Indicator Unit. After the trouble has been so isolated, you should refer to Section 2 of this manual or to the appropriate plug-in manual for further troubleshooting information.

If you have more than two plug-in units (one or more spares), the easiest way to isolate trouble is to replace the existing plug-in units, one at a time, with the spares. Then by noting when proper operation is restored, you can determine which unit is at fault. If plug-in replacement does not correct the trouble, then the Indicator Unit is probably faulty.

Whenever you encounter an apparent trouble in the instrument, you should be sure that it is not due to improper control settings. (For example, improper settings of the SOURCE and COUPLING switches on a time-base unit can produce apparent triggering troubles; an improperly set VARIABLE control can produce an apparent decrease in sensitivity.) Then check the front-panel calibration adjustments. (An improperly set STABILITY adjustment on a time-base unit can cause apparent triggering problems; an improper dc balance setting can cause the trace or spot to be positioned completely off the screen when the POSITION control is at midrange.)

When it has been determined that a trouble definitely exists, and that trouble has been isolated to a given unit, perform a complete visual check of that unit. Many troubles, such as loose wires, faulty switches, and improperly seated tubes, can be found most easily by visual inspection. Also check for scorched parts. You should find and eliminate the cause of overheating before replacing a scorched part.

Faulty tubes are the most prevalent cause of circuit troubles. Therefore, if a visual check fails to reveal the cause of trouble, you should check all tubes in the suspected

circuit, one at a time. Always check tubes by substitution; tube testers cannot adequately determine the suitability of a tube to perform a given function. If there are numerous tubes in the suspected circuit, the most satisfactory method of checking them is to replace all of them, and then return original tubes, one at a time, until the faulty tube is discovered. Be sure to return all good tubes to their original sockets; otherwise you may have to recalibrate the instrument unnecessarily because of different tube characteristics of the same tube type.

If tube substitution does not correct the trouble, then you must check the rest of the circuit by voltage and resistance measurements. Voltages at various points throughout the instrument are included on the circuit diagrams. These voltages are typical nominals only and, with the exception of power supply voltages, may vary considerably from instrument to instrument. Resistance measurements in a circuit will usually be point-to-point checks for which the proper values can be approximated from the schematic diagrams. Wherever possible, to facilitate circuit tracing, the wiring in the Type RM561 Oscilloscope is color-coded to follow the standard EIA code. The —100-volt bus is coded brown-black-brown; the +125-volt bus is coded brown-red-black; and the +300-volt bus is coded orange-black-brown.

The switch wafers shown on the Calibrator diagram are coded to indicate the position of the wafer on the switch. Wafers are numbered from the front of the switch to the rear. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function.

Sometimes it may be necessary to move a plug-in from one opening to another in order to gain access to the particular part of the circuit you wish to check. If, for some reason, you do not wish to move the plug-ins to work on them, a plug-in extension (Tek part no. 013-034) is available which allows the units to be operated while partially extended out through the front of the oscilloscope (see the Accessories Section).

Normally, a trouble in the oscilloscope will be discovered through an erroneous display (or no display at all) on the crt. For this reason, the following troubleshooting information is divided according to the symptoms presented to the operator.

No Trace or Spot

If you are unable to obtain a trace on the screen, remove both modules and vary the INTENSITY control. A spot should appear on the screen. If it does not appear, the trouble is in the Indicator Unit. If a spot does appear when both modules are removed, reinsert each separately and vary its POSITION control. If the spot or trace cannot be returned to the approximate center of the screen when either of the modules is inserted, the trouble is in that module.

Insufficient Deflection

If the horizontal or vertical deflection cannot be set to the proper value with the GAIN ADJ. or CALIBRATION adjustment on the front panel, you should check the power supply voltages at pins 10, 15, 16 and 23 of the plug-in connectors, and the high voltage (—3300 volts) at the cathode of the crt. If these voltages are all within tolerances shown on the Plug-In Connector diagram, the trouble lies in one of the plug-ins—if there is insufficient vertical deflection, it is in the left-hand unit; if there is insufficient horizontal deflection, it is the right-hand unit.

If the power supply voltages are not as specified, remove both plug-ins and check the voltages again. If they still are not as specified, the trouble is in the Indicator Unit. If the power supply voltages are correct with both plug-ins removed, but incorrect with either inserted, the trouble is in that plug-in. Check the resistances to ground of the faulty unit from its plug-in connector. If the resistances are correct, the trouble is in the power supply of the Indicator Unit.

Improper Sweep Timing

If improper sweep timing is encountered (and cannot be corrected with the front-panel CALIBRATION adjustment on the time-base plug-in), you should first check the power supply voltages at the plug-in connectors and the high voltage (—3300 volts) at the crt cathode. If these voltages are as specified on the schematic diagram, the trouble is in the time-base plug-in. If one or more of these voltages are not as specified, proceed as described in the preceding paragraph.

Improper Triggering

If external triggering and line triggering are satisfactory but internal triggering is not, the trouble is probably in the Trigger Pickoff circuit of the amplifier plug-in you are using. If satisfactory triggering cannot be obtained from any of the three sources, the trouble is probably in the time-base plug-in.

Waveform Distortion

If there is an excessive amount of waveform distortion, but no other indications of malfunction (such as improper sweep timing or insufficient deflection), the trouble is in the plug-in which is amplifying the signal.

CALIBRATION

The Type RM561 Oscilloscope should be calibrated after each 500 hours of operation, or every six months, whichever occurs first. In addition, the calibration of a unit should always be checked and adjusted as necessary after replacement of any part.

Procedures for calibrating the Indicator Unit are given in Section 2 of this manual. Procedures for calibrating the plug-in units are given in the plug-in manuals.

Normally, the instrument will be calibrated with both plug-in units inserted. When performing a complete calibration, you should calibrate the Indicator Unit first, then the amplifier unit or units, and then the time-base unit, if one is used. Either or both of the plug-in units can be calibrated separately although the power-supply voltages in the Indicator Unit should always be checked before calibrating any part of the instrument.

NOTES

SECTION 2

INDICATOR UNIT

INTRODUCTION

The Indicator Unit of the Type RM561 Oscilloscope contains a low-voltage power supply, a cathode-ray tube and associated circuitry (including a high-voltage power supply), and a calibrator.

The low-voltage power supply provides regulated and unregulated voltages for use throughout the instrument.

The crt circuit contains the necessary controls and adjustments for presenting a sharp trace of desired intensity to display the signals applied to the deflection plates by the plug-in units. The high-voltage power supply provides —3300 volts (the major portion of the accelerating potential) for the crt cathode.

The calibrator produces an amplitude-calibrated square wave for use in setting the gain of the amplifier plug-ins and the timing of the time-base plug-ins. The settings of the CALIBRATOR control indicate the peak-to-peak amplitude of the square wave available at the CAL. OUT connector. The negative half-cycle is at ground potential.

The numbered settings of the SCALE ILLUM. control may be used as an exposure guide for photographing waveforms on the Type RM561 Oscilloscope. The numbers indicate the recommended lens opening for the camera when using the type of film and exposure time specified on the panel below the control. Before taking photographs, remove the red graticule lamp inserts and adjust the trace intensity so that it is about the same as the graticule lines. Each time you make a significant change in the sweep rate of a time-base unit, the trace intensity should be readjusted so that it remains about the same as the graticule intensity.

You can modulate the intensity of the crt trace by applying a modulating signal to the CRT GRID connector at the rear of the oscilloscope. A negative-going signal of about 20 volts is required to cut off the beam from normal intensity.

CIRCUIT DESCRIPTION

Low-Voltage Power Supply

Power for the Type RM561 Oscilloscope and its plug-in units is supplied through the power transformer T601. The two primary windings of T601 are connected in parallel for 117-volt operation, or in series for 234-volt operation, as shown on the schematic diagram.

The secondary of T601 has nine secondary windings. Five of these windings provide 6.3 volts ac for the vacuum tube heaters and the pilot and graticule lights in the instrument. The remaining four windings provide power to the regulated supplies. The supplies produce regulated voltages of —100, —12, +125, and +300 volts. The unregulated side of each supply (except the —12-volt supply) is available at the plug-in connectors to provide shunt paths around the series regulator tubes for those plug-ins requiring current beyond the capability of the tubes. These shunt paths are completed in the plug-ins themselves, as necessary. In addition, the unregulated side of the +300-volt supply (approximately +420 volts) is used in the crt high-voltage supply.

All of the regulator circuits are of the series type; that is, a vacuum tube (or transistor, in the case of the —12-volt supply) in series with the load regulates the current through the load in such a manner as to maintain a constant voltage drop across the load. As the load increases (resistance of the load decreases), the series tube allows more current to flow; as the load decreases (resistance of the load increases), the series tube allows less current to flow.

The basic reference for all of the regulated voltages is the fixed drop across the voltage regulator tube, V609. The nature of this tube is such that it maintains a constant voltage drop of approximately 85 volts across itself regardless of the current through it, within rather wide limits. This constant drop directly establishes the reference for the —100-volt supply, and the —100-volt supply is then used as the reference for the other regulated supply voltages.

Manual adjustment of the —100-volt output is provided by the —100 VOLTS adjustment, R616. V609 holds the grid of V634A at a fixed potential of about +85 volts with respect to the —100-volt supply. Adjustment of R616 varies the grid of V634B with respect to the —100-volt supply, and therefore with respect to the grid of V634A. The voltage difference between the two grids of V634 determines the current through V634B and therefore sets the voltage at the grid of the series regulator tube, V627. Since the cathode of V627 is connected directly to ground, this determines the bias on the tube. Changing the bias on V627 changes its effective impedance, thereby increasing or decreasing the current through it and through the load. The change is such that moving the arm of R616 in the positive direction (toward ground) decreases the current through the load, thereby decreasing the voltage drop across the load. In other words, the output of the —100-volt supply drops. Moving the arm of R616 in the negative direction (toward the supply output) increases the current through the load, thereby increasing the voltage drop across the load. In other words, the output of the —100-volt supply rises. During calibration, R616 is set so that the output of the —100-volt supply lies as near to —100 volts as possible.

Regulation of the —100-volt supply takes place as follows. Any change in the output voltage produces exactly the same change at the grid of V634A due to the fixed drop across V609. The change which appears at the grid of V634B is less than one-sixth as great, due to the voltage-divider action of R616, R617, and R618. The resulting change in the relative levels of the two grids increases or decreases the current through V634B. This, in turn, changes the grid level of V627. The corresponding increase or decrease in the effective resistance of V627 changes the current through the load and brings the output voltage back toward its original level.

For example, suppose that the output of the supply drops from —100 volts to —99 volts due to a change in the load. This one-volt drop causes the grid of V634A to move

positively by one volt, taking both cathodes of V634 with it. The grid of V634B, meanwhile, also moves positively, but by less than one-sixth of one volt. Since the cathode of V634B moves nearly one volt and the grid moves less than one-sixth of a volt, the bias on the tube is increased by more than five-sixths of a volt. The current through V634B therefore decreases. This causes the voltage at the plate of V634B and grid of V627 to become more positive. The more positive voltage on the grid of V627 allows more current to flow through the load which increases the voltage drop across the load back to —100 volts.

Regulation of the +125-volt supply is accomplished in the following manner. With the lower end of R561 fixed at —100 volts, any change in the +125-volt output produces a proportional change in bias on V654. This change is amplified and applied to the grid of the series regulator tube, V667A. The change at the grid of V667A is opposite in polarity to the initial change at the output resulting in an increase or decrease in the bias on V667A. The resulting increase or decrease in the effective impedance of V667A changes the current through the load in such a manner as to bring the drop across the load back toward its nominal value. C650 improves the response of the regulator circuit to sudden changes in output voltage.

A small sample of the unregulated-bus ripple appears at the screen of V654 through R657. This ripple signal appearing at the screen (which acts as an injector grid) produces a ripple component at the grid of V667A which is opposite in polarity to the ripple appearing at the plate of V667A. This tends to cancel the ripple at the cathode of V667A, and hence reduces the ripple on the +125-volt bus. This same circuit also improves the regulation of the circuit in the presence of line voltage variation.

The +300-volt supply functions in the same manner as the +125-volt supply. Rectified voltage from terminals 7 and 14 of the power transformer is added to the voltage supplying the +125-volt regulator to supply power for the +300-volt regulator.

Operation of the —12-volt regulating circuit is essentially the same as that of the other regulating circuits, except that transistors are used instead of vacuum tubes. The base of Q734 is fixed near —12 volts due to the voltage divider action of R731 and R732 between —100 volts and ground. Any variation from —12 volts at the emitter of Q734 is amplified by Q734 and Q744 to change the effective impedance of Q757 which is in series with the load. F720 protects the transistors in case of an overload on the —12-volt supply.

CRT Circuit

The cathode-ray tube normally supplied with the Type RM561 Oscilloscope is a Tektronix Type T503RP2. P1, P7, and P11 phosphors are optionally available; other phosphors are available on special order. The accelerating potential is approximately 3500 volts, provided by a potential of about —3300 volts at the crt cathode and an average potential of about +200 volts at the deflection plates. The nominal vertical and horizontal deflection factors are approximately 23 and 19 volts per centimeter, respectively, with this accelerating potential.

The —3300-volt supply for the crt cathode operates as follows: V800, the primary of T801, and the circuit capacitance (indicated by the dotted capacitor symbol on the schematic diagram) form a Hartley oscillator circuit which operates at about 50 kc. The output of the oscillator is stepped up in T801 and half-wave rectified by V822 to provide a dc potential of about —3400 volts at the plate of V822. The drop across R849, R847, and R852 places the crt cathode at about —3300 volts.

Regulation of this voltage is accomplished through feedback from the arm of R841. If, due to loading or change in input voltage, the output of the high-voltage supply should change, a proportional change at the arm of R841 would be coupled through V814 to the screen grid of V800. This would change the amplitude of oscillations in V800 and T801 in such a manner as to bring the plate of V822 back toward its original level.

The crt bias voltage, developed across R847 (INTENSITY control) and R852, varies from about 20 volts to 75 volts as R847 is moved through its range. At normal intensity the drop across R847 is in the vicinity of 45 to 55 volts. The focusing voltage at the arm of R844 (FOCUS control) varies from about —2300 volts to about —2900 volts with respect to ground as R844 is moved through its range.

Deflection-plate unblanking is used in the Type RM561 Oscilloscope crt. The voltages at the unblanking deflection plates (pins 6 and 7) are controlled by the right-hand plug-in unit. Normally, when the screen is unblanked, there is a potential of +125 volts on both plates. As long as the two unblanking deflection plates are at the same potential, the beam is not deflected toward either and passes on through to the crt screen. If one of the unblanking deflection plates is at a significantly higher positive or negative potential than the other, the electron beam will be deflected and absorbed by the accelerating anode; therefore, the screen will be blanked. Further discussion of the unblanking voltages is included in the time-base and sweep plug-in manuals.

C760 and C761 (shown on the Plug-In Connectors diagram) provide a means for adjusting the effective capacity of the crt deflection plates, as seen by each plug-in in the instrument. (The "effective" deflection-plate capacity is the capacity seen by the plug-in at terminals 17 and 21 of the plug-in connectors when the two terminals are driven by equal voltages of opposite phase, which is the case in all plug-ins with a push-pull output.) This capacity affects the bandpass and the amount of phase shift through the plug-in. C760 and C761 are adjusted at the factory to provide an effective deflection-plate capacity of 16 picofarads at the plug-in connectors of both openings.

The CRT BEAM ROTATOR adjustment, R860, provides a means of radially shifting the position of a trace or display so that it is exactly parallel with the horizontal graticule markings. This is done by varying the magnitude and polarity of a magnetic field produced by L860 which is located around the front portion of the cathode-ray tube.

Calibrator

The basic calibrator for the Type RM561 Oscilloscope produces a line-frequency amplitude-calibrated square wave.

In the line-frequency calibrator, the 6.3-volt (approximately

18 volts peak-to-peak) ac heater voltage for V884 is applied through C876 to the cathode of V884A, driving that tube into and out of cutoff at the line-frequency rate. The signal at the plate of V884A is then coupled to the grid of V884B to turn that tube on and off. Regenerative feedback from the plate of V884B to the grid of V884A speeds up the switching action of V884A.

The voltage present at the cathode of V884B during the time that V884B is conducting can be set to exactly 100 volts with the CAL. AMPL. adjustment, R871. The voltage divider in the cathode circuit of V884B contains precision resistors to provide an output accuracy of 3% or better at the various settings of the CALIBRATOR control.

TROUBLESHOOTING

General maintenance and troubleshooting information is contained in Section 1 of this manual. In the following discussion it is assumed that you have read that information and have definitely isolated a trouble to the Indicator Unit by the procedures described there.

The first step in troubleshooting the Indicator Unit is to measure the power-supply voltages at pins 10, 15, 16 and 23 of the interconnecting plugs. (Two plug-in units which have been checked for proper resistance between the plug-in connectors and ground should be inserted. If one is a time-base unit, its TIME/DIV. control should be set to EXT. INPUT.) If all of the voltages are not as indicated, the trouble is in the low-voltage power supply or the power source. To check these, refer to the paragraph entitled Troubleshooting the Power Supply. If all of these voltages are proper, the trouble is in the Crt Circuit. In this case, refer to the paragraph entitled Troubleshooting the Crt Circuit.

Troubleshooting the Power Supply

If there is no power present anywhere in the instrument (power-supply outputs, graticule lights, tube filaments) check the primary circuit of T601. Check especially the fuse, the thermal-cutout switch, the POWER ON switch, and the power source. If all of these are operating satisfactorily, check the primary of T601 for continuity. If the graticule lights or any of the tube filaments are lighted, the primary circuit of T601 may be assumed to be operating properly. On 117-volt operation, check the thermal cutout if the fan is running.

If one or more of the supplies fails to regulate, check the line voltage. It should be between 105 and 125 volts rms for an instrument wired for 117-volt operation, or between 210 and 250 volts rms for an instrument wired for 234-volt operation. If it is not, then the power source will need to be brought within these limits in order for the instrument to perform properly.

If the line voltage is within the specified limits, and one of the power-supply output voltages is not correct, check that particular regulator circuit. If none of the voltages are correct, the trouble is probably in the —100-volt supply, since this voltage serves as a reference for the other circuits.

To check a regulator circuit, first replace the tubes as described in Section 1. If this does not eliminate the trouble, check the rest of the circuit by voltage and resistance measurements. One cause of insufficient voltage might be an open or shorted rectifier diode.

If there is excessive ripple on any of the supplies, replace the filter capacitor or capacitors (C640A, C642A, C644, C720, or C721).

Troubleshooting the CRT Circuit

To locate a trouble within the Crt Circuit, first remove the high-voltage shield, shown in Fig. 2-2, and see if the filament of the high-voltage rectifier, V822, is glowing. If it is, measure the voltage at the plate of V822; it should be about —3400 volts with respect to ground.

If the voltage at the plate of V822 is about —3400 volts, measure the potentials in the high-voltage divider and at the other points in the circuit for which typical voltages are given on the schematic diagram. If all of these voltages are correct, then the crt itself is probably faulty and should be checked.

If the filament of V822 is glowing but the voltage at its plate is significantly less than —3400 volts, measure the resistance from the plate of V822 to ground; it should be about 20 megohms. If it is, then the trouble is in V822 or in the secondary of T801. If the resistance between the plate of V822 and ground is significantly less than 20 megohms, locate the trouble by resistance checks throughout the rest of the circuit.

If the filament of V822 is not glowing, measure the voltage at the control grid of V800. It should be about —85 volts with respect to ground. If it is, the high-voltage oscillator is operating and the trouble lies in V822 or in the secondary of T801. If the voltage at the control grid of V800 is significantly less than —80 volts, then the oscillator is not operating properly. However, you must make certain circuit checks before replacing V800 to prevent possible damage to the replacement tube. First, measure the voltage at the plate of V800; it should be about +400 volts. If it is not, then the trouble lies in the plate circuit. If the voltage at the plate of V800 is about +400 volts, check the primary and secondary resistance of T801. The resistance of the primary should be about 40 ohms, and the resistance of the secondary (between the filament of V822 and ground) should be about 170 ohms. Check C807 and C822 to make sure that they are not shorted. Also check the resistance between the plate of V822 and ground; it should be about 20 megohms. If all of these resistances are correct, then replace V800 and V814. If tube replacement does not eliminate the trouble, check the rest of the circuit by voltage and resistance measurements.

CALIBRATION

The following equipment is required for complete calibration of the Type RM561 Oscilloscope Indicator Unit:

1. Dc voltmeter (sensitivity of at least 5000 ohms per volt), calibrated for an accuracy of 1% or better from 0 to 300 volts, and for an accuracy of 3% or better at 4000 volts.

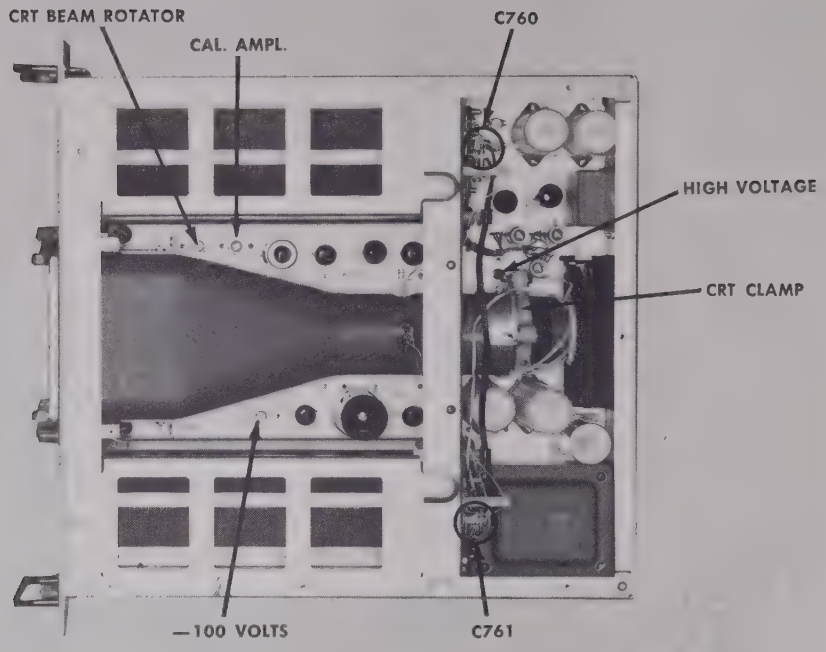


Fig. 2-1. Top view of Type RM561 showing location of internal adjustments.

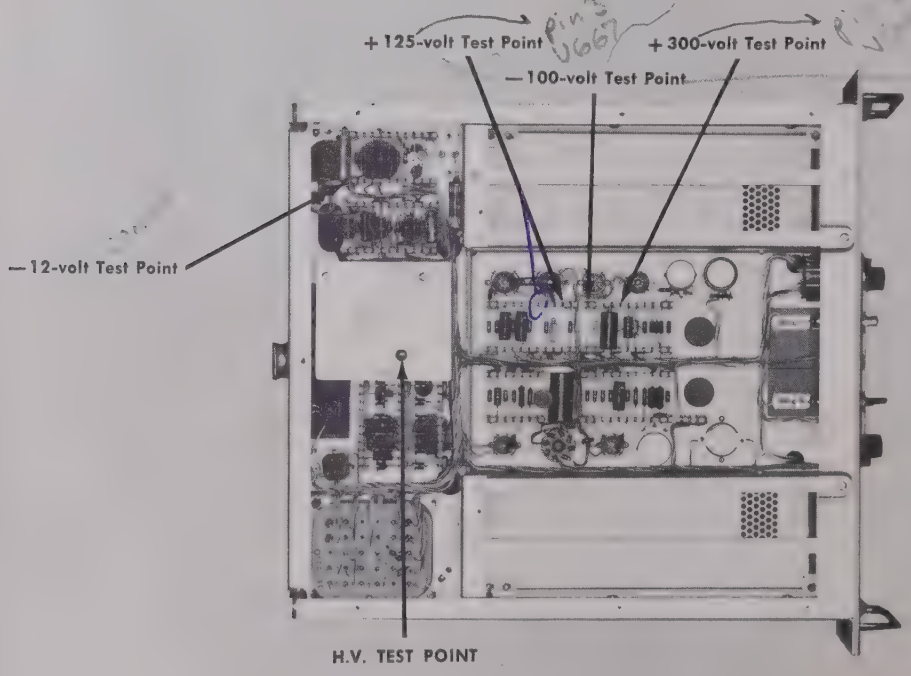


Fig. 2-2. Bottom view of Type RM561 showing voltage check points.

2. Variable autotransformer with a rating of at least 250 watts.

3. Accurate rms-reading ac voltmeter with a range of at least 0 to 125 volts (0 to 250 volts for 234-volt instruments).

4. Test oscilloscope with calibrated vertical sensitivity of 50 millivolts per division or better.

5. Capacitance meter capable of a measurement accuracy of 0.1 picofarad or better at 16 picofarads; meter must have guard voltage available. Tektronix Type 130 L-C Meter recommended.

To set up the Type RM561 for calibration of the Indicator Unit, insert two plug-in units known to be in proper operating condition. If one is a time-base plug-in unit, set its TIME/DIV. switch to EXT. INPUT. Connect the autotransformer to a suitable power source and connect the Type RM561 Oscilloscope to the output of the autotransformer. Turn on the equipment and set the output of the autotransformer for the nominal operating voltage of the oscilloscope (117 volts or 234 volts). Allow the equipment to warm up for about 10 minutes.

Power Supply

With the dc voltmeter, measure the output of the —12-, —100-, +125-, and +300-volt supplies at pins 16, 23, 15, and 10, respectively, of the plug-in connectors. Set the —100 VOLTS adjustment (Fig. 2-1) so that all of the supplies are within 3% of their rated values.

NOTE

Do not adjust the —100 VOLTS adjustment unless one or more of the supplies is actually out of tolerance or unless you are planning to perform a complete calibration of the instrument.

Measure the voltage at the high-voltage test point (indicated on the high-voltage shield, Fig. 2-2). Adjust the HIGH VOLTAGE adjustment (Fig. 2-1) for a reading of —3300 volts.

Using the test oscilloscope, measure the amount of 120-cps ripple at the output of each power supply, except the —3300-volt supply. (For line frequencies other than 60 cps, the ripple will be twice the line frequency.) The ripple should not exceed 20 millivolts on the —100-volt supply, 15 millivolts on the +125-volt supply, 80 millivolts on the +300-volt supply, and 10 millivolts on the —12-volt supply. Do not attempt to measure the ripple on the —3300-volt supply.

Vary the autotransformer output voltage between 105 and 125 volts (or 210 and 250 volts if the power transformer is wired for 234-volt operation) and check to see that all voltages stay within tolerance over this range.

CRT Circuit

Check to see that the face of the crt rests snugly against the graticule. If it does not, loosen the crt clamp screw (Fig. 2-1) and move the tube forward by pushing on the tube socket. Then retighten the crt clamp screw.

Set the plug-in controls to produce a spot at the center of the crt. Set the FOCUS control fully counterclockwise and adjust the ASTIG. control so that the defocused spot is as nearly circular as possible. The INTENSITY control may have to be adjusted to produce the defocused circle, but care should be taken not to burn the crt phosphor when the spot is adjusted for sharp focus.

If you are using a time-base unit, set it for a free-running trace. If you are not using a time-base unit, apply a signal to the right-hand plug-in to produce a horizontal trace at least 10 centimeters long. Set the FOCUS control for the narrowest trace width and position the trace directly behind one of the graticule lines. Adjust the CRT BEAM ROTATOR as necessary to align the trace with the graticule line.

Calibrator

Set the CALIBRATOR switch to OFF and the CAL. AMPL. adjustment (Fig. 2-1) so that the voltage at the cathode of V884B (pin 7) is exactly +100 volts. Calibration of the various settings of the CALIBRATOR switch is not necessary.

Effective Deflection-Plate Capacity

The effective deflection-plate capacity of the cathode-ray tube, as seen by the plug-ins, can be adjusted by means of C760 and C761. This capacity has been set at the factory to provide a standard effective deflection-plate capacity of 16 picofarads for all instruments. If C760 or C761 has been inadvertently misadjusted, or if the cathode-ray tube has been changed, the effective capacity between one or both pairs of plates may be altered slightly. This is of consequence only if you are using a wide-band amplifier plug-in (such as the Type 75) near the limit of its bandpass or if you are using two plug-in amplifiers for X-Y phase comparison. If the proper response cannot be obtained throughout the bandwidth of a wide-band amplifier, or if X-Y phase measurements differ when the amplifier units are interchanged between openings, the effective deflection-plate capacity is probably not at the proper value at one or both plug-in connectors.

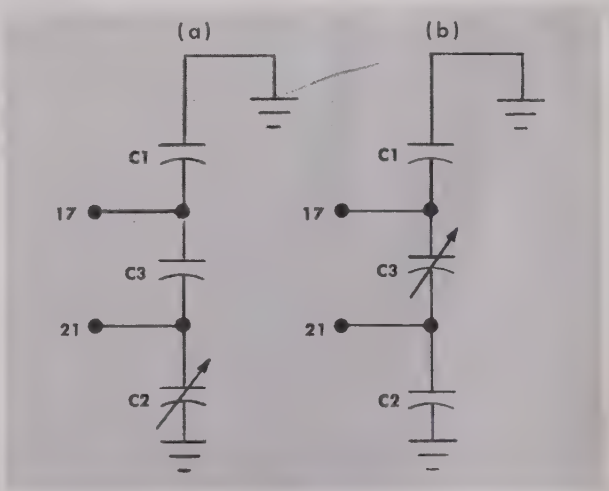


Fig. 2-3. Schematic representation of effective deflection-plate capacity: (a) left-hand opening; (b) right-hand opening.

Since the effective deflection-plate capacity of the cathode-ray tube is that capacity seen by the plug-in when the plates are driven push-pull, it cannot be measured directly with a capacitance meter. However, the circuit capacitances which make up the effective deflection plate capacity can be measured with the meter. These capacitances may be schematically represented as shown in Fig. 2-3. Because of the slight differences of the physical layouts of the left- and right-hand openings, the variable capacitors, C760 and C761, are connected differently in each opening. Their effect, however, is the same in both openings as each is capable of changing the effective deflection-plate capacity so that it may be set to a standard value. C1 and C2 in Fig. 2-3 represent the capacity from each deflection plate to ground and C3 represents the capacity between each set of deflection plates. In the left-hand opening of the Indicator Unit, variable capacitor C760 is part of the capacitance of C2. In the right-hand opening, variable capacitor C761 is part of the capacitance of C3. Since the deflection plates are driven push-pull, the effective deflection-plate capacity, C_{eff}, may be expressed in terms of C1, C2 and C3 as follows:

$$C_{eff} = \frac{C1 + C2}{2} + 2C3.$$

In the left-hand opening, C1 and C3 are fixed and C2 is adjustable by means of C760. In the right-hand opening, C1 and C2 are fixed but vary slightly from instrument to instrument and C3 is adjustable by means of C761. Setting C_{eff} equal to 16 picofarads (the factory standard) and rearranging terms for each opening, we obtain:

For the left-hand opening: $C2 = 32\ pf - (C1 + 4C3)$

For the right-hand opening: $C3 = 8\ pf - \frac{C1 + C2}{4}$

Thus, measuring C1 and C3 in the left-hand opening, we can determine the desired value for C2. Once the desired value of C2 has been determined for the left-hand opening, we can obtain this value by adjusting C760. Correspondingly, by measuring C1 and C2 in the right-hand opening, we can determine the desired value for C3 which we can then set with variable capacitor C761.

To set the effective deflection-plate capacity of either Indicator Unit opening, proceed as follows:

1. Disconnect the power cord and isolate the oscilloscope from ground.

2. Either plug a 24-pin mating connector into the appropriate plug-in connector or insert any plug-in unit into the appropriate opening and unsolder the leads from terminals 17 and 21 in the plug-in.

3. Connect the capacitance meter guard voltage to pin 21 of the plug-in connector and measure the capacity between pin 17 and the oscilloscope chassis—this is C1.

4. If you are setting the capacity of the left-hand opening, connect the capacitance meter guard voltage to the oscilloscope chassis and measure the capacity between pins 17 and 21 of the plug-in connector—this is C3. If you are setting the capacity of the right-hand opening, connect the capacitance meter guard voltage to pin 17 and measure the capacity between pin 21 and the oscilloscope chassis—this is C2.

5. Substitute the measured capacitance values into the appropriate equation and solve for C2 (for the left-hand opening) or for C3 (for the right-hand opening).

6. If you are setting the capacity of the left-hand opening, connect the guard voltage to pin 17 of the plug-in connector and measure the capacity between pin 21 and the oscilloscope chassis. If you are setting the capacity of the right-hand opening, connect the guard voltage to the oscilloscope chassis and measure the capacity between pins 17 and 21 of the plug-in connector.

7. For the left-hand opening, adjust C760 (see Fig. 2-1) until the measured capacity in step 6 equals the value of C2 obtained in step 5. For the right-hand opening, adjust C761 (see Fig. 2-1) until the measured capacity in step 6 equals the value of C3 obtained in step 5.

NOTE

Now that you have set the effective deflection-plate capacity in one of the openings, the other opening can easily be set by the use of a wide-band amplifier such as the Type 75. If you have an amplifier such as the Type 75 proceed with the following steps to set the deflection-plate capacity of the other opening. If you do not have an amplifier with a bandwidth from dc to at least 4 megacycles, you can complete the calibration by applying steps 1 through 7 to the other opening.

8. Disconnect the capacitance meter and resolder any unsoldered leads.

9. Insert a Type 75 (or other amplifier with a bandwidth from dc to at least 4 megacycles) in the calibrated opening of the oscilloscope and a time-base unit in the opposite opening. Turn the oscilloscope on.

10. Calibrate the wide-band amplifier for best square-wave response according to the Calibration procedures in the plug-in manual.

11. Interchange the positions of the two plug-in units.

12. Apply the same square wave used in the calibration of the wide-band amplifier plug-in to the INPUT connector.

13. Adjust C760 or C761, whichever is applicable, for best square-wave response on the screen.

The calibrated wide-band amplifier can now be used as a standard against which to calibrate the deflection-plate capacity of other Type 561 Oscilloscopes. This eliminates the necessity of repeating the entire procedure for each instrument to be standardized. Simply insert the calibrated plug-in in each opening to be calibrated (and a time-base plug-in in the other opening), apply the square wave used in calibrating the plug-in, and adjust C760 or C761, whichever is applicable, for best square-wave response on the screen.

SECTION 3
POWER SUPPLY ADDENDUM

Introduction

This section has been prepared to acquaint the maintenance technician with the various power-supply voltages and currents available from Type 561 and RM561 Indicator Units.

The information presented may also be of value to the design engineer who may wish to build his own signal amplifier plug-in unit. A blank plug-in chassis with detailed power supply information is available for this purpose; order Modification Kit number 040-245 from your local Tektronix Field Office or Representative.

The information in this section may be subject to minor changes due to production modifications during manufacturing.

TYPE 561, RM561 INDICATOR POWER SUPPLY LIMITS

The Tektronix Type 561 and RM561 Indicator Units provide power for the plug-in circuits. The total dc power available is 85 watts, divided between four regulated supplies. Current capabilities of both the regulated dc supplies and unregulated ac supplies are listed in Table 3-1. Use of current from the unregulated dc supply leads is not recommended.

The four regulated dc supplies listed in Table 3-1 should not all be operated at maximum current at the same time. If all four were to be used to their current limits, the total regulated power would be 93 watts, 8 watts above the maximum value. This limit should be no problem however, since it is rare that all supplies would ever be used at their maximum values at the same time.

TABLE 3-1

TYPE 561, RM561 POWER SUPPLY CURRENT CAPABILITIES FOR PLUG-INS

SUPPLY	MAX. TOTAL CURRENT	CONNECTOR TERMINALS
Reg. —100 vdc	130 ma	23— to 9 ground
Reg. —12 vdc	1.5 amps	16— to 5 ground
Reg. +125 vdc	150 ma	15+ to 9 ground
Reg. +300 vdc	150 ma	10+ to 9 ground
Unreg. 6.3 vac	5 amps per plug-in	1 — 2
Line 117 vac†	8 amps* total or 5 amps** per plug-in	7 — 8
Line 234 vac	4 amps	7 — 8

†In cases of 234-volt line, do not use power transformer as an autotransformer to obtain 117 volts for plug-in.

*Total of 10 amps limited by power cord; 8 amps for plug-ins, 2 amps for power transformer.

**Total of 5 amps per plug-in limited by interconnecting plug at rear of each plug-in unit.

Since the Type 561 and RM561 Indicator Units employ two plug-in units to operate the X and Y axis of the crt, currents listed in Table 3-1 are normally divided between them. However, a single plug-in alone can be used, such as a vertical amplifier, with moving-film recording used instead of a horizontal sweep. In such a case it will be necessary to elevate the crt horizontal deflection plates to approximately +180 to +210 volts dc to permit proper focus and astigmatism control.

The limit on how much power can be dissipated in one plug-in unit is based primarily upon the ambient temperature and amount of ventilation supplied. Vacuum tubes should not be operated with envelope temperatures above 150° C when the ambient temperature is at 25° C, or above 175° C when the ambient temperature is at 50° C. The Type 561 Indicator Unit can be operated in ambient temperatures up to 50° C.

SUGGESTED POWER SUPPLY SHUNT RESISTOR VALUES

To make efficient use of the Type 561 or RM561 Indicator Unit power supplies, the load currents for each supply and maximum or minimum load values must be known.

The nature of series regulated power supplies permits obtaining more current from them than can normally be handled by the series tube alone (providing the power transformer and rectifiers can supply more current). By placing a shunt resistor of appropriate value across the series regulator tube, additional current can be made available for the load. The correct value shunt resistor must be chosen to permit the regulator system to deliver current with low ripple, and the shunt resistor must have a power rating high enough to carry its share of current without overheating.

To permit the best selection of shunt resistors, Table 3-2 lists current limits for three conditions of the —100-volt, +125-volt and +300-volt dc supplies. The currents listed are one-half the total available, based upon the total current being divided between two plug-ins. Do not shunt any other supply.

TABLE 3-2

RECOMMENDED TYPE 561, RM561 REGULATED POWER SUPPLY SHUNT RESISTORS*

SHUNT RESISTOR VALUES	—100 v	+125 v	+300 v
No Shunt	0 to 25 ma	0 to 45 ma	0 to 40 ma
2000Ω, 5w between proper terminals of power connector.	20 to 45 ma	25 to 60 ma	35 to 67 ma
SHORT, between proper terminals of power connector.	40 to 65 ma	50 to 75 ma	65 to 75 ma

*Currents listed are one-half total available, based on two plug-in units being used.

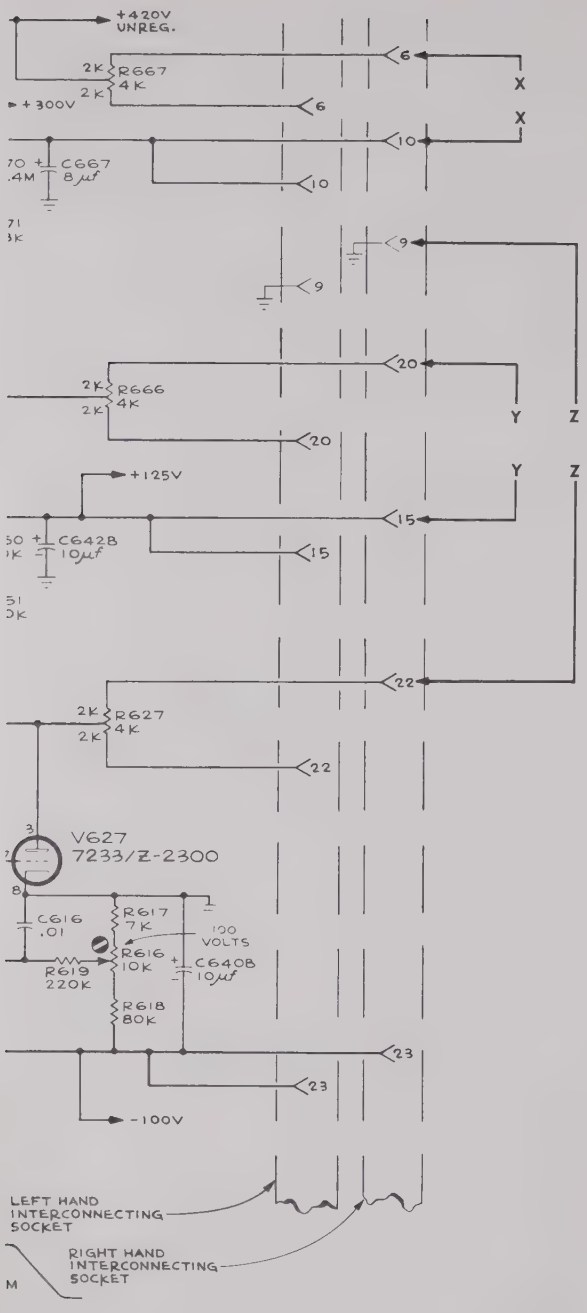


Fig. 3-1. Power supply shunt resistor connections.

Table 3-3 lists the proper plug-in interconnecting plug terminals for connection of power supply shunt resistors.

TABLE 3-3

PLUG-IN INTERCONNECTING PLUG TERMINALS FOR REGULATED SUPPLY SHUNT RESISTORS

SUPPLY	TERMINALS
—100	22 — 9 return
+125	20 — 15 return
+300	6 — 10 return

As indicated on the power supply schematic, separate terminals are provided for the ground return of the —12-volt regulated heater supply. When using this supply in your own plug-in design, it is best to run two leads to the heater terminals so that the ground lead can be connected directly to terminal 9, thus eliminating ground currents. If your instrument indicates +6-volt unregulated terminals, do not draw current from these terminals.

A portion of the power supply schematic has been reproduced in Fig. 3-1, identifying interconnecting plug terminals specified in Table 3-3.

Use of shunt resistor values suggested in Table 3-2 will lead to a minimum of total power required, and give lowest plug-in temperature. It is the simplest method that will not overtax supplies, either for regulation or temperature. However, if Table 3-2 does not meet your design needs, refer to the curves of Figs. 3-2, 3-3 or 3-4 to aid your choice of individual power supply shunt resistors.

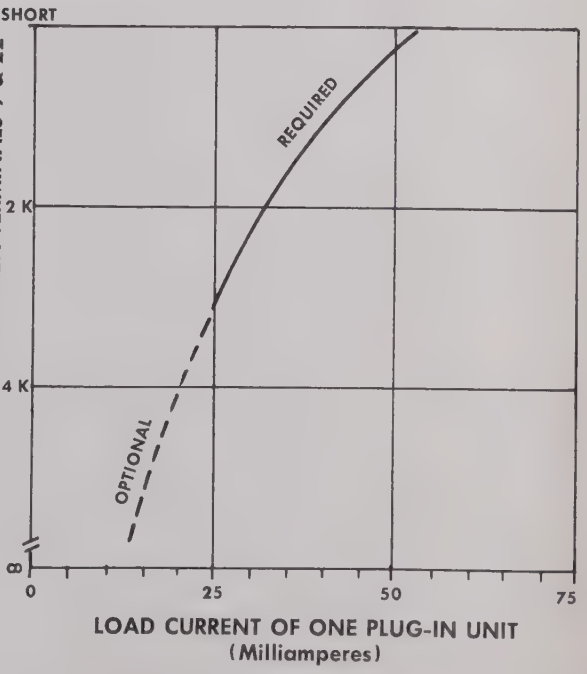


Fig. 3-2 —100-volt supply shunt.

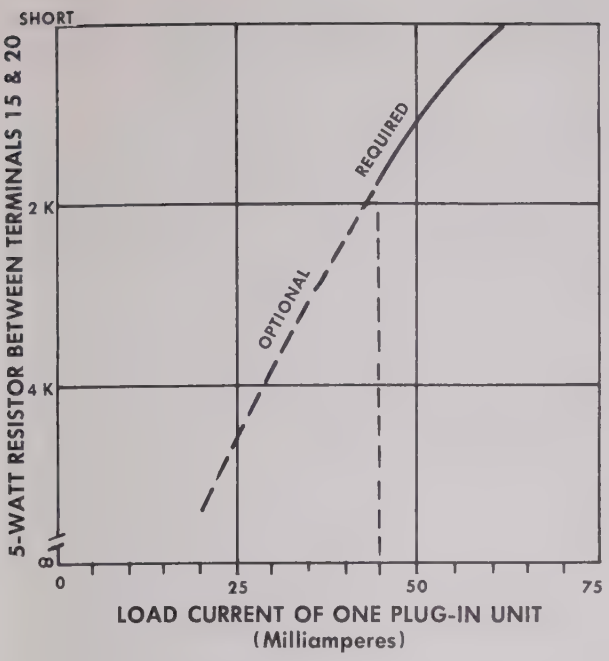


Fig. 3-3. +125-volt supply shunt.

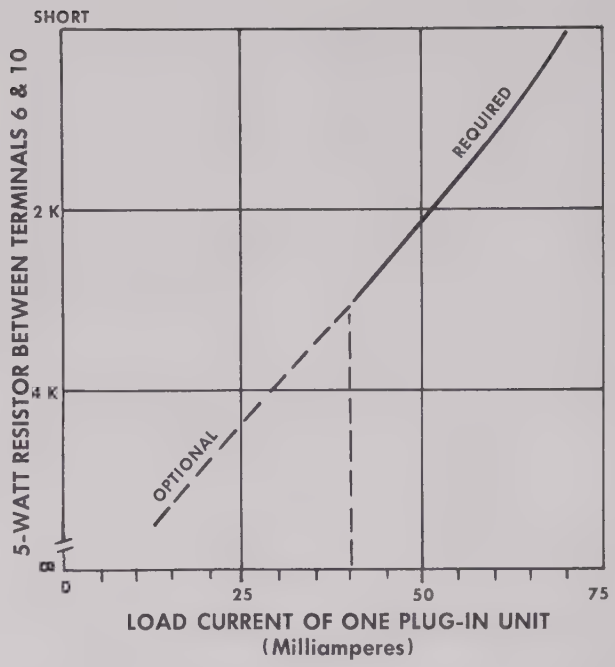


Fig. 3-4. +300-volt supply shunt.

NOTES

ACCESSORIES
SECTION 4

The Type 561/565/567 series of Tektronix oscilloscopes will fit many measurement applications and systems through use of standard and special accessories listed in this section.

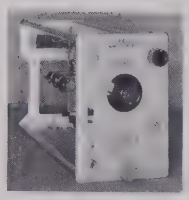
Accessories should be ordered by type or part number through your local Tektronix Field Office or Representative. Complete, up-to-date price information is also available through your local Field Office or Representative.

Additional plug-in units and other accessories will be made available as new applications develop. If you are faced with a measurement problem which is not solved adequately by existing Tektronix plug-in units or combinations of plug-in units and amplifiers, consult your local Field Engineer or Representative.

SIGNAL AMPLIFIER PLUG-IN UNITS FOR THE 560-SERIES OSCILLOSCOPES

The Type 560 Oscilloscope is designed to use any of the Tektronix plug-in units numbered 50 through 69. The Type 561/565/567 series of oscilloscopes will accept plug-in units numbered 50 through 79. The basic difference between the Type 560 and the other 560-series oscilloscopes is the amount of power available from the indicator power supplies.

Tables 4-1 and 4-2 list all plug-in units currently available from 50 through 79, and their general characteristics. Probes are not included with the plug-in units and should be ordered separately. Probes satisfactory for use with the plug-in units are listed in Tables 4-10 and 4-11.



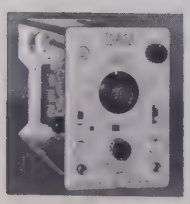
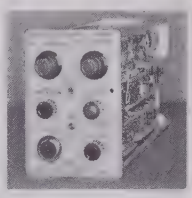
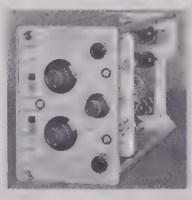


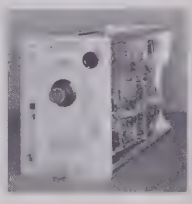
TABLE 4-1
AMPLIFIER PLUG-IN UNITS FOR TYPE 561/565/567 OSCILLOSCOPES

General Description	Type	3-db Frequency Response	Input	Calibrated Deflection Factors
Basic, AC-Coupled	50	15 cps to 200 kc	1 meg Ω	1 mv/div
Basic, DC-Coupled	59	Dc to 400 kc	250 k	Approximately 1 v/div
General Purpose	60	Dc to 1 mc	1 meg Ω, 47 pf	50 mv/div to 50 v/div in 4 calibrated steps
Low-Level AC Differential	61*			50 μv/div
High-Gain DC Differential	63	Dc to 300 kc each channel	1 meg Ω, 47 pf each channel	1 mv/div to 20 v/div in 14 calibrated steps. Differential rejection ratio up to 2000:1
Dual-Trace DC-Coupled	72	Dc to 650 kc each channel	1 meg Ω, 47 pf each channel	10 mv/div to 20 v/div in 11 calibrated steps
Wide-Band DC-Coupled	75	Dc to 4 mc	1 meg Ω, 47 pf	50 mv/div to 20 v/div in 9 calibrated steps
Four Channel	74*			20 mv/div
Sampling	76*			

* In development stage at time of printing.







The Type 61 Differential Amplifier requires a special input connector; order part number 131-008.

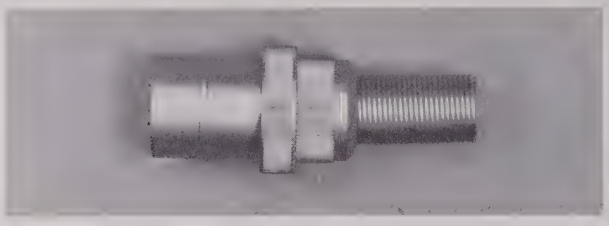
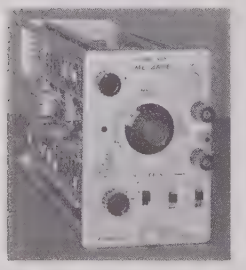


TABLE 4-2
TIME-BASE PLUG-IN UNITS
FOR TYPE 561/565/567 OSCILLOSCOPES

General Description	Type	Calibrated Sweep Range	Sweep Magnifier
Simplified Time-Base	51	5 msec/div	Variable, approximately 1X to 20X
Basic Time-Base	67	1 μsec/div to 5 sec/div in 21 calibrated steps	5X
Sampling	77*		

* In development stage at time of printing.



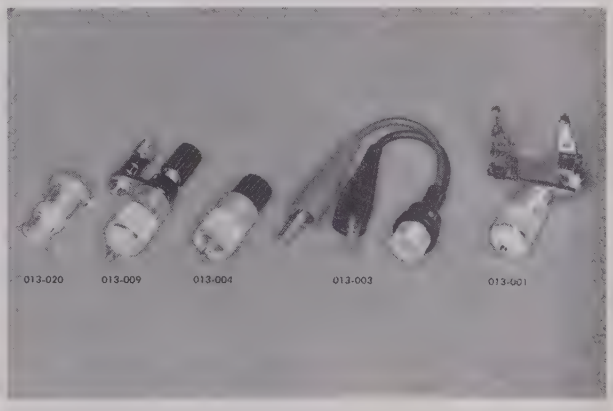
PLUG-IN EXTENSION

Maintenance of 560-series plug-in units can be made easier by using the Plug-in Extension pictured here. Fits all 560-series indicators and plug-in units. Order part number 013-034.

TABLE 4-3
COAXIAL CONNECTOR ADAPTORS

Description	Part Number
Component test fixture. Intended for use with Type 130 L-C Meter. Fitted with UHF Plug.	013-001
Clip leads fitted with UHF Jack.	013-003
Single Binding Post fitted with UHF Plug.	013-004
Dual Binding Post fitted with UHF Plug.	013-009
P6000 Probe Adaptor. Fitting, BNC Plug.*	013-020
BNC Jack to UHF Plug. Fits BNC Plug and UHF Jack.	103-015
UHF Coupling. Jack on each end. Fits UHF Plug on each end.	103-025
UHF T Connector. Fits one UHF Jack to two UHF Plugs.	103-026
UHF Elbow. Fits UHF Jack to UHF Plug. (Not shown)	103-027
BNC Coupling. Jack on each end. Fits BNC Plug on each end.	103-028
BNC Coupling. Plug on each end. Fits BNC Jack on each end.	103-029
BNC T Connector. Fits one BNC Jack to two BNC Plugs.	103-030
BNC Elbow. Fits BNC Jack to BNC Plug.	103-031
BNC Plug to UHF Jack. Fits BNC Jack and UHF Plug.	103-032
Single Binding Post fitted with BNC Jack.	103-033

* The BNC Probe Adaptor permits connecting a BNC coaxial system to any P6000 or P6017 series probe. If cable requires termination, see Table 4-9 for proper BNC termination unit. Items of Tables 4-3 and 4-4 permit a probe to be fitted to almost any coaxial system.



COAXIAL CONNECTOR ADAPTORS

Some electronic equipment is designed with coaxial connectors different from those provided on Tektronix oscilloscopes. Table 4-3 lists adaptors that will permit you to join many of the modern connector styles to your 560-series

signal amplifier for greater versatility of measurement and use. Or, the adaptors may be used to mate other systems using dissimilar coaxial connectors.

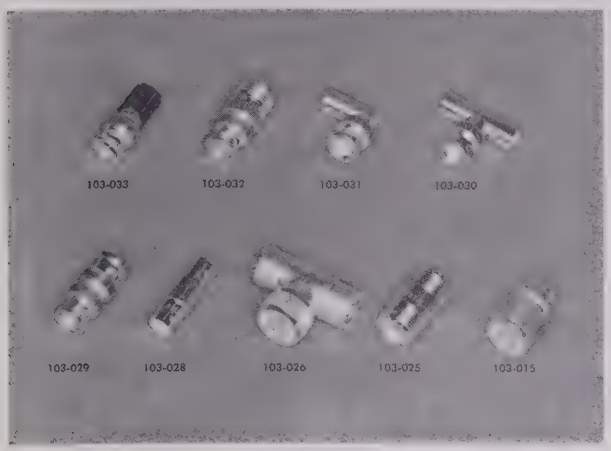


TABLE 4-4
50 Ω GR TYPE 874-Q ADAPTORS

Description*	Part Number
Type 874 connector and Type N Jack. (GR Type 874-QNJ) Fits Type N Plug.	017-020
Type 874 connector and Type N Plug. (GR Type 874-QNP) Fits Type N Jack.	017-021
Type 874 connector and Type UHF Jack. (GR Type 874-QUJ) Fits Type UHF Plug.	017-022
Type 874 connector and Type UHF Plug. (GR Type 874-QUP) Fits Type UHF Jack.	017-023
Type 874 connector and Type BNC Jack. (GR Type 874-QBJ) Fits Type BNC Plug.	017-024
Type 874 connector and Type BNC Plug. (GR Type 874-QBP) Fits Type BNC Jack.	017-025
Type 874 connector and Type C Jack. (GR Type 874-QCJ) Fits Type C Plug.	017-026
Type 874 connector and Type C Plug. (GR Type 874-QCP) Fits Type C Jack.	017-027

*** Typical VSWR for two connectors, paired, to 2000 megacycles: Type BNC, less than 1.07; Type N, less than 1.04; and Type C, less than 1.04.**

COAXIAL CABLES

Coaxial cables with several connector styles are listed in Table 4-5. (Signals take 5 nsec to pass through 40" of 50-ohm cable.)

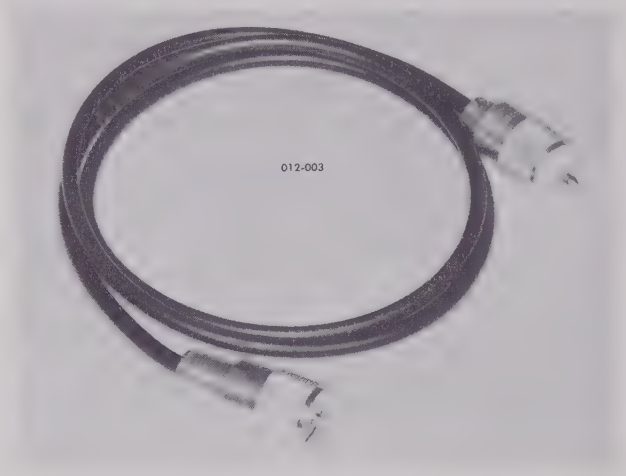


TABLE 4-5
COAXIAL CABLES

Description	Part Number
Two UHF plug connectors. 50 Ω nominal impedance. 42" long. RG-58A/U.	012-001
Two UHF plug connectors. 75 Ω nominal impedance. 42" long. RG-59A/U.	012-002
Two UHF plug connectors. 93 Ω nominal impedance. 42" long. RG-62A/U.	012-003
Two UHF plug connectors. 93 Ω nominal impedance terminated with 93 Ω, ½-watt resistor in unpainted end. 42" long.	012-005
Two UHF plug connectors. 170 Ω nominal impedance. 42" long.	012-006
Two UHF plug connectors. 170 Ω nominal impedance. 60" long.	012-034
Two BNC plug connectors. 50 Ω nominal impedance. 42" long. RG-58A/U.	012-057
Two GR 874 connectors. 50 Ω nominal impedance. 80", 10-nsec delay. RG-58A/U.	017-501
Two GR 874 connectors. 50 Ω nominal impedance. 40", 5-nsec delay. RG-8A/U.	017-502
One GR 874 connector, other end pigtail. 50 Ω nominal impedance. 8", 1-nsec delay. RG-58A/U.	017-503
Two GR 874 connectors. 50 Ω nominal impedance. 120", 20-nsec delay. RG-8A/U.	017-504
Two GR 874 connectors. 50 Ω nominal impedance. 16", 2-nsec delay. RG-58A/U.	017-505

INTERCONNECTING LEADS

Several types of interconnecting leads are listed in Table 4-6. These are valuable when patching between circuits or between panel connectors of Tektronix oscilloscopes.

TABLE 4-6
INTERCONNECTING LEADS

Description	Part Number
Type W130B. Black, 30" flexible output lead with banana plug at one end and alligator clip at other.	012-014
Type W130R. Same as Type W130B except colored red.	012-015
Type PC-6B. Black, 6" flexible cord with combination plug and jack banana-type connectors on each end.	012-023
Type PC-6R. Same as Type PC-6B except colored red.	012-024
Type PC-18R. Similar to Type PC-6B except 18" long and colored red.	012-031
Type W531B. Black, 6" flexible cord with plug banana-type connectors on each end.	012-028
Type W531R. Same as Type W531B except colored red.	012-029

TABLE 4-7
UHF SYSTEM ATTENUATORS
Fittings: One UHF Plug-One UHF Jack

Description	Part Number
50 Ω 10:1 T Attenuator, 1.5 watts.	011-031
50 Ω 5:1 T Attenuator, 1.5 watts.	011-032
75 Ω 10:1 T Attenuator, 1.5 watts.	011-033
75 Ω 5:1 T Attenuator, 1.5 watts.	011-034
93 Ω 10:1 T Attenuator, 1.5 watts.	011-035
93 Ω 5:1 T Attenuator, 1.5 watts.	011-036

UHF SYSTEM ATTENUATORS

When working with UHF coaxial systems in the range of 30 megacycles and below, the attenuators listed in Table 4-7 will function properly when terminated with a termination resistor of the same value. Termination resistors are listed in Table 4-8.

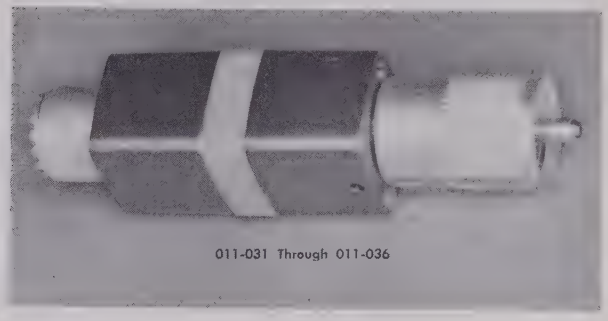


TABLE 4-8
UHF SYSTEM TERMINATIONS
Fittings: One UHF Plug-One UHF Jack

Description	Part Number
52 Ω Terminating Resistor, 1.5 watts	011-001
75 Ω Terminating Resistor, 1.5 watts	011-007
93 Ω Terminating Resistor, 1.5 watts	011-011
170 Ω Terminating Resistor, 0.5 watt	011-016
50 Ω to 75 Ω Minimum Loss Attenuator	011-041 Replaces 011-004
50 Ω to 93 Ω Minimum Loss Attenuator	011-042 Replaces 011-014
50 Ω to 170 Ω Minimum Loss Attenuator	011-043 Replaces 011-005

HIGH FREQUENCY BNC CONNECTOR TERMINATIONS AND ATTENUATORS

Tektronix offers a series of terminating resistors and attenuators, having a BNC Plug on one end and a BNC Jack on the other. The attenuators have a VSWR of less than 1.1, when properly terminated, to 200 megacycles. Table 4-9 lists the BNC group.

Any of the BNC terminations and attenutors may be used with a Tektronix 560-series oscilloscope by adding the proper adaptor (listed in Table 4-3). For example, to adapt a BNC Plug to a UHF Jack, select part number 103-015.

It is often necessary to terminate a coaxial system when connecting it to the input of an oscilloscope. Proper termination with a resistance equal to the cable characteristic impedance will prevent signal reflections and avoid measurement errors.

If the signal requires attenuation at the oscilloscope input, a 10:1 T attenuator of the correct impedance can be used. However, a T attenuator alone is not a correct cable termination and must be followed by the proper termination resistor.

Observe the power rating stamped on the case of the terminations and attenuators. Dissipation of power in excess of the ratings may destroy the resistance element inside the unit.

TABLE 4-9
BNC TO BNC COAXIAL TERMINATIONS AND ATTENUATORS

Fittings: One BNC Plug-One BNC Jack

Description	Part Number
50 Ω Cable Termination, ½ watt.	010-313
50 Ω 10:1 T Attenuator, ½ watt.	010-314
75 Ω Cable Termination, ½ watt.	010-315
75 Ω 10:1 T Attenuator, ½ watt.	010-316
93 Ω Cable Termination, ½ watt.	010-317
93 Ω 10:1 T Attenuator, ½ watt.	010-318
50 Ω to 75 Ω Minimum Loss L Attenuator, 1 watt.	010-319
50 Ω to 93 Ω Minimum Loss L Attenuator, 1 watt.	010-320

SIGNAL AMPLIFIER INPUT CAPACITANCE STANDARDIZER

Standardization of signal amplifier input capacitance is important when exchanging attenuator probes between units. The overall amplifier attenuator plus probe frequency response is degraded if all input time constants are not equal. Standardizer for 47-pf (input capacitance) plug-in units; 4X attenuation: order part number 011-021.

PROBES

The most common method of connecting signals to a 560-series signal amplifier is to use a probe of appropriate attenuation. An attenuator probe significantly reduces the loading on the circuit being measured below the loading value of the signal amplifier input terminals.

Several probe types are listed in Tables 4-10 and 4-11.

P6017-Series Probes—The P6017-series of probes preserves the transient response of Tektronix 560-series instruments. The 42-inch cable length of P6017 and P6022 Probes provides uniform amplitude response with no overshoot or ringing. Average bandpass characteristics show the P6017 and P6022 Probes, with 42-inch cables, to be down between 0 and 1 db at 30 megacycles. 12-foot cables reduce bandpass to 3 db down between 16 and 20 megacycles.

Four interchangeable tips—spring, hooked, pincher, and banana tip—are included with the probe. A 12-inch ground lead is also included.

TABLE 4-10
P6017-SERIES PROBE SPECIFICATIONS

Probe and Connector	Cable Length	Atten. Ratio	Input Impedance			Voltage Rating (Max.)
			Resistance Meg Ω	Capacitance—pf Min.*	Max.**	
	42 inch	10	10	14	14	600
P6017-UHF	6 foot	10	10	17	17	600
P6022-BNC	9 foot	10	10	20	20	600
	12 foot	10	10	23	23	600
	42 inch	1	1	67	94	600
P6027-UHF	6 foot	1	1	94	120	600
P6028-BNC	9 foot	1	1	120	147	600
	12 foot	1	1	146	173	600

*When connected to instruments with 20-pf input capacitance.

**When connected to instruments with input capacitance up to 50 pf.

TEKTRONIX PART NUMBERS

Length	P6017	P6022	P6027	P6028
42 inch	010-038	010-064	010-070	010-074
6 foot	010-056	010-066	010-071	010-075
9 foot	010-057	010-067	010-072	010-076
12 foot	010-058	010-068	010-073	010-077

100X Probes—Probes having an attenuation ratio of 100 are listed in Table 4-11. These probes are provided in the event you require very small capacitive loading when measuring signals of high impedance, or if it is necessary to measure voltages higher than 600 volts. They will perform with uniform amplitude response without overshoot or ringing on any of the 560-series signal amplifiers.

Physical dimensions of the probe body are $^{7}/_{16}$ inch in diameter and $3^{5}/_{8}$ inches in length without the tip. The standard cable length is 42 inches.

Four interchangeable tips—spring, hooked, BNC, and banana tip—are included with the probe. A 5-inch and a 12-inch ground lead are also included.

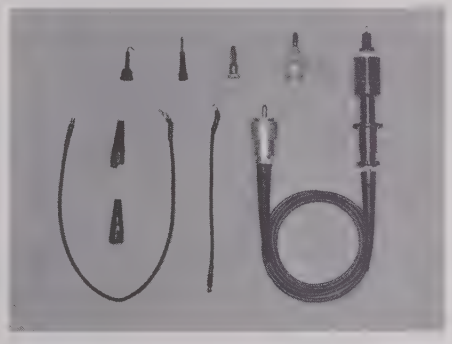


TABLE 4-11
100X PROBE SPECIFICATIONS

Probe and Connector	Cable Length	Atten. Ratio	Input Impedance			Voltage Rating (Max.)
			Resistance Meg Ω	Capacitance—pf Min.*	Max.**	
	42 inch	100	9.1	2.5	2.8	2000
P6002-UHF	6 foot	100	9.1	2.8	3.25	2000
P6005-BNC	9 foot	100	9.1	3.5	4.0	2000
	12 foot	100	9.1	3.8	4.0	2000

*When connected to instruments with 20-pf input capacitance.

**When connected to instruments with input capacitance up to 50 pf.

TEKTRONIX PART NUMBERS

Length	P6002	P6005
42 inch	010-024	010-029
6 foot	010-034	010-050
9 foot	010-043	010-051
12 foot	010-044	010-052

P6016 AC Current Probe System—The P6016 Current Probe with the Type 131 Current Probe Amplifier or the Passive Termination constitute an ac current detecting system for use with an oscilloscope. The system provides accurate displays for observation and measurement of ac current waveforms. Current range extends from less than one milliampere to 15 amperes.

Use of the Current Probe and Amplifier system with any of the 560-series signal amplifiers will result in an upper-frequency limit similar to that of the plug-in unit used; this will be less than the upper-frequency limit of the probe system alone.

P6016 Probe and Type 131 Amplifier

Sensitivity (with 50 mv/div oscilloscope input) 1 ma/div to 1 amp/div in 10 steps. Variable sensitivity control on oscilloscope provides continuous uncalibrated adjustment.

Frequency Range (with 30-megacycle oscilloscope)—3 db down at 50 cps and approximately 17 mc.

Risetime—20 nsec.

Saturation Ratings—DC, 0.5 amp; AC, 15 amps peak-to-peak decreasing to 8 amps at 400 cps, 400 ma at 50 cps.

P6016 Probe and Passive Termination

Sensitivity—2 ma/mv and 10 ma/mv.

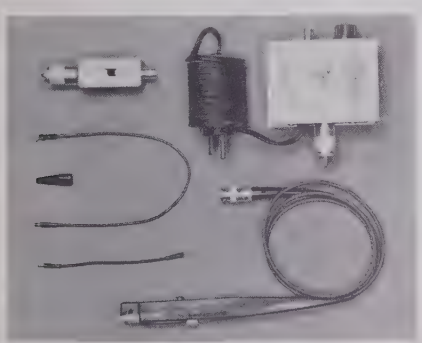
Frequency Range (with 30-megacycle oscilloscope)—3 db down at 850 cps (2 ma/mv), 230 cps (10 ma/mv), and 20 megacycles.

Risetime—18 nsec.

Saturation Ratings—DC, 0.5 amp; AC at 2 ma/mv, 15 amps peak-to-peak decreasing to 8 amps at 1.5 kc, 4 amps at 850 cps; at 10 ma/mv, 15 amps peak-to-peak decreasing to 5 amps at 400 cps, 2.5 amps at 230 cps.

The long narrow shape and convenient thumb control make the P6016 Current Probe easy to use. Just place probe slot over the conductor and close slide with thumb—no direct electrical connection is required. Wiping action keeps core surfaces clean. Loading introduced is so slight that it can almost always be disregarded. For increased sensitivity, loop the conductor through the probe slot two or three times.

Order part number 010-037



P6014 High-Voltage Probe—This new probe provides a means of observing waveforms of high amplitudes. Dc amplitudes to 12 kv or short pulses with peak amplitudes to 25 kv can be measured without damage to the probe.

Attenuation Ratio—1000.

Frequency Response—Dc to over 30 mc.

Input Impedance—10 megohms and 3 pf.

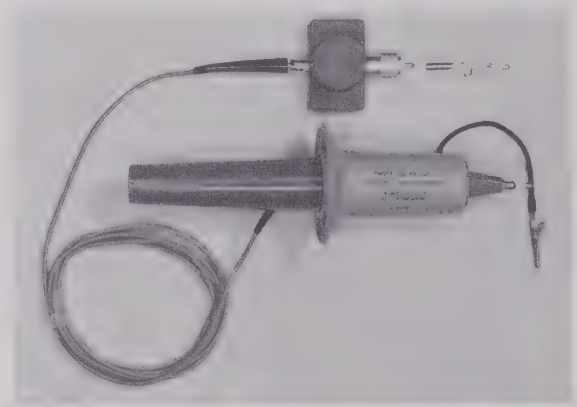
Pulse Rating—10% or less duty cycle for 25 kv pulses, with maximum pulse duration of 0.1 sec.

A compensating box at the oscilloscope end of the probe cable enables the P6014 to be properly compensated to any oscilloscope having an input capacitance of 20 to 47 pf. The probe introduces no ringing or overshoot.

Probe body length is 12 inches, coaxial cable length is 10 feet.

The probe includes 2 banana-plug tips, an alligator-clip assembly, and an attached 7½-inch ground lead.

Order part number 010-025



P500CF Cathode-Follower Probe—Presents low capacitance with minimum attenuation. Input impedance is 40 megohms paralleled by 4 pf. Gain: 0.8 to 0.85. Input to probe is ac-coupled, limiting its low-frequency response to 5 cycles. Amplitude distortion is less than 3% on unidirectional signals to 5 volts. 10X attenuator head is included with probe, and should be used on signals exceeding a few volts to minimize amplitude distortion. With the attenuator head attached, the probe input impedance is approximately 10 megohms paralleled by 2 pf. Probe output level is 11 v positive, making it necessary to use the ac-coupled position of the oscilloscope AC-DC switch. Probe cable is 42" long.

Order part number 010-105

TYPE 128 PROBE POWER SUPPLY

Probe power supply for P500CF and P170CF cathode-follower probes. The Type 128 supplies the necessary plate and filament voltages for one or two probes, making it possible to use the cathode-follower probes with signal amplifiers not equipped with a probe-power outlet.

DC Output Voltages:

+120 v regulated, at 25 ma.

Two +6.3 v unregulated, at 150 ma.

The two cathode-follower probe connections have separate +6.3 v dc voltage supplies.

Voltage ripple on the +120-v supply is not more than 5 mv peak-to-peak, and not more than 75 mv peak-to-peak on the +6.3-v supplies.

Power Requirements—105 to 125 v or 210 to 250 v, 50 to 60 cycles, 25 watts using two P500CF Probes.

Dimensions—4¾" wide, 7¾" high, 9" overall depth.

Weight—6 lbs.

TABLE 4-12

560-SERIES INDICATOR CATHODE-RAY TUBES

Indicator	CRT Type	Part Number
560	T503P2*	154-265
561	T503P2*	154-265
RM561	T503RP2*	154-320
565	T565P2*	

* P-1, P-7, P-11, or P-31 phosphors supplied at no additional charge on special request.

TABLE 4-13
CRT VIEWING HOODS

Indicator	Part Number
560	016-001
561	016-001
RM561	No hood available
565	016-001

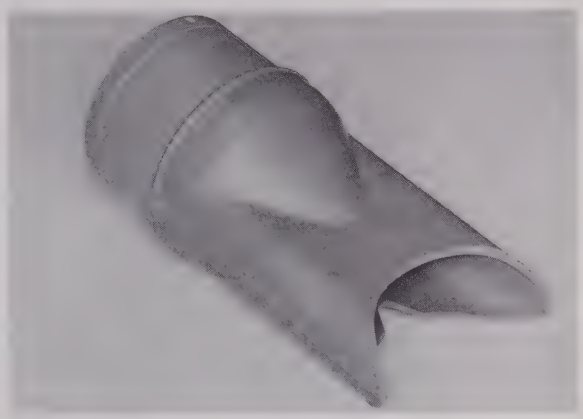


TABLE 4-14
CRT GRATICULES

Indicator	Scribed Area	Part Number
560	8 x 10 cm	331-056
561	8 x 10 cm	331-056
RM561	8 x 10 cm	331-076
565	8 x 10 cm	331-056
Special for Types 560 or Type 561 for phase measurements.		331-057

RECALIBRATION TOOLS

The tools shown are handy, and in some cases necessary, for the recalibration of Tektronix instruments. All of the tools except the assembly 003-007 are available through most radio and electronic parts suppliers. Tools marked with a √ are necessary for recalibration of 560-series instruments.

003-001 Jaco No. 125 insulated screwdriver with 7" shank and metal bit. This tool is useful for hard-to-reach adjustments.

003-000 Jaco No. 125 insulated screwdriver. This tool is similar to 003-001 but has a 1½" shank.

003-003 Walsco No. 2519 insulated alignment tool. This double-ended tool is useful for adjusting variable inductors.

003-004 Walsco No. 2503, ¼" insulated hexagonal wrench. This tool is useful for tightening variable inductor lock nuts.

003-006 (Not pictured) Insulated alignment tool suitable for adjusting small capacitors.

003-007 Tektronix recalibration tool assembly. This 4-unit tool assembly provides most of the necessary tools for adjusting variable inductors in Tektronix instruments.

003-301 Walsco No. 2543 double-ended 0.1" hexagonal wrench. This tool is useful for adjusting variable inductors with hexagonal cores.

Alignment tool kit: contains the following tools.

003-001	003-004	003-308
003-000	003-006	003-309
003-003	003-307	003-310

Part No. for kit 003-500

OSCILLOSCOPE TABLE

The Tektronix Type 201 Scope-Mobile® provides a mobile support for medium-size oscilloscopes or other electronic instruments. Designed for the busy engineer, the easily adjustable (through nine 4.5° steps) tray places the instrument at desk height and at any convenient angle for optimum viewing. Mounted on 5-inch rubber tired wheels, the Scope-Mobile table is easily moved around the work area. An optional plug-in carrier makes it convenient to store extra oscilloscope plug-in units (560/561 series), keeping them dust-free and minimizing the possibility of damage. Order plug-in carrier separately as part number 014-007.

® Registered trademark, Tektronix, Inc.

RM561 CHASSIS MOUNTING TRACKS

Chassis-Trak® slides designed for the Tektronix RM561 fit standard rack cabinets, and the prepunched mounting holes on the sides of the RM561 Indicator make installation an easy matter.

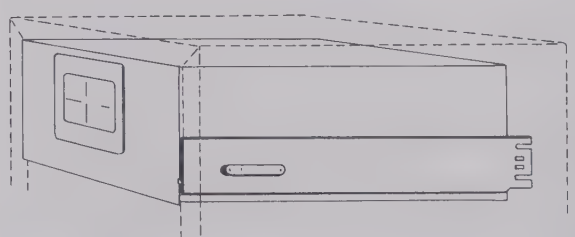
Three styles of Chassis-Trak are available.

1. A low-cost, non-tilting assembly. Not illustrated.
2. A basic tilting style assembly that has no locking position other than a horizontal rest position. 18" instrument travel.
3. The Detent Tiltlok assembly including 7 detent locking positions for easy servicing. 16" instrument travel.

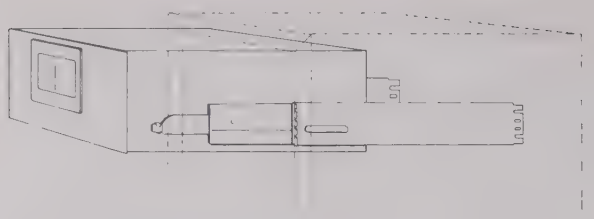
Ordering

1. Non-tilting. Type RM561, MOD 17, part number 351-040.
2. Basic Tilt. Type RM561, MOD 17, part number 351-051.
3. Detent Tiltlok. Type RM561, MOD 171.

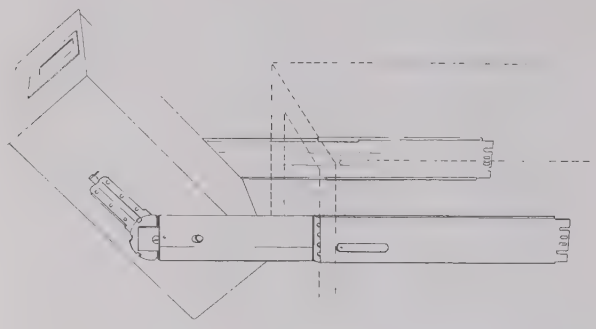
® Registered trademark, Chassis-Trak Corp.



Chassis-Trak installed in operating position within cabinet.



Basic tilt style extended from cabinet.



Detent Tiltlok style extended and locked at 45° angle.

CAMERAS

Type C-12 Camera*

Interchangeable Lens—Lens easily changed by loosening two adjustable locknuts. Lenses available are f/1.5, f/1.9, and f/4.5. Object-to-image ratios include 1:1, 1:0.9, 1:0.7, 1:0.5.

Interchangeable Back—Accepts all standard Graflok accessories. Backs may be interchanged without refocusing.

Binocular Viewing—Orthogonal and undistorted over full 8 x 10 cm area.

Hinge Mounting—Camera swings away from crt screen for full visibility, lifts easily out of hinge fittings.

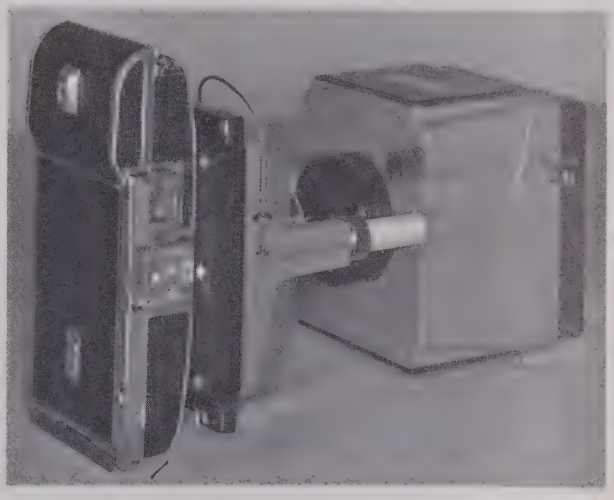
Rotating and Sliding Backs—Rotation through 90° steps. Horizontal or vertical movements of back through five positions.

Standard C-12 Camera shipped with f/1.9 Oscillo-Raptar lens having 1:0.9 object-to-image ratio, focusing 4 x 5 Graflok back, and Polaroid roll-film back.

Type C-13 Camera*

Same style as the C-12 except that it does not have the binocular viewing feature. Standard lens supplied with the C-13 Camera is an f/4.5 Oscillo-Amaton which has an object-to-image ratio of 1:0.7. Other lenses currently available from Tektronix will fit the C-13.

Other features of the C-13 Camera are similar to those of the C-12.



Type C-19 Camera*

Same style as the C-12 Camera except that it is constructed without a beam-splitting mirror to permit maximum light from the oscilloscope screen to reach the camera lens. This feature in conjunction with the fast f/1.5 lens supplied with the camera make the C-19 particularly suitable for applications requiring extremely high writing rates. Other lenses currently available from Tektronix may be used with the C-19.

Binocular viewing of a 5 cm high by 10 cm wide screen area permits the oscilloscope display to be observed while being photographed.

Other features of the C-19 Camera are similar to those of the C-12.

*** When ordering your camera, please specify the oscilloscope(s) it is to be used with.**

AUXILIARY DEVICES

Type BE510 Bezel

Type BE510 Bezel for mounting other than Tektronix cameras on Tektronix 5" oscilloscopes. Dimensions: 5⅞" square; ring ⅞" deep, diameter 5⅝" outside, 5⅛" inside. Die-cast construction, wrinkle finish, felt lined. Not usable on Type RM561. Gray, part number 014-001A; Blue, part number 014-001B.

Type 110 Pulse Generator and Trigger Takeoff

Pulse Risetime—Less than 0.25 nsec.

Pulse Length—Minimum of 0.5 nsec to 300 nsec at half rep rate.

Pulse Output Impedance—50 ohms.

Pulse Repetition Rate—Nominally 720 pulses/sec.

Trigger Systems—50-ohm impedance. Takeoff system where signal is patched into a "loop-through" arrangement and a portion of signal used as a trigger signal. Regenerated trigger system with trigger output ±10 v amplitude, 225 nsec duration, 4 nsec 50% risetime, count down from approximately 100 mc.

Type 111 Pretrigger Pulse Generator

Risetime—0.5 nsec for positive pulse, slightly longer for negative pulse.

Pulse Duration—2 nsec minimum, 100 nsec maximum at low rep rates decreasing to 20 nsec at 100-kc rep rate (obtained with external charge line).

Pulse Repetition Rate—10 pps to 100 kc in 4 ranges with continuously variable control.

Pulse Amplitude—More than ±5 volts.

Pretrigger Pulse Characteristics—10 volts, 250 nsec duration, half-amplitude risetime about 4 nsec.

Pulse Delay—Continuously variable from 30 to 250 nsec after pretrigger pulse.

Output Impedance—50 ohms.

Type 1121 Amplifier

Voltage Gain—100 with 9 calibrated attenuator steps to provide net gain from 100 to 0.2.

Frequency Response—5 cycles to 17 mc, decreasing slightly with increase in attenuator setting.

Risetime—21 nsec.

Maximum Output Voltage—±1 v in terminated 93-ohm cable.

Type 130 L-C Meter

Guard Voltage—Permits measuring an unknown capacitance while eliminating the effects of other capacitances from the measurements.

Five Ranges:
Microhenries: 0 to 3, 10, 30, 100, 300.
Picofarads: 0 to 3, 10, 30, 100, 300.

Accuracy—Within 3% of full scale.

Type 105 Square-Wave Generator

Risetime—13 nsec, with 52-ohm termination.

Frequency Range—25 cycles to 1 mc, continuously variable.

Frequency Meter—Direct reading, accurate within 3% of full scale.

Output Amplitude—0 to 100 v maximum, 0 to 15 v across 93-ohm load.

Type 107 Square-Wave Generator

Risetime—Less than 3 nsec, with 52-ohm internal termination.

Frequency Range—400 kc to 1 mc, uncalibrated.

Output Amplitude—0.1 v to 0.5 v, with 52-ohm terminated cable.

Type 123 Preamplifier

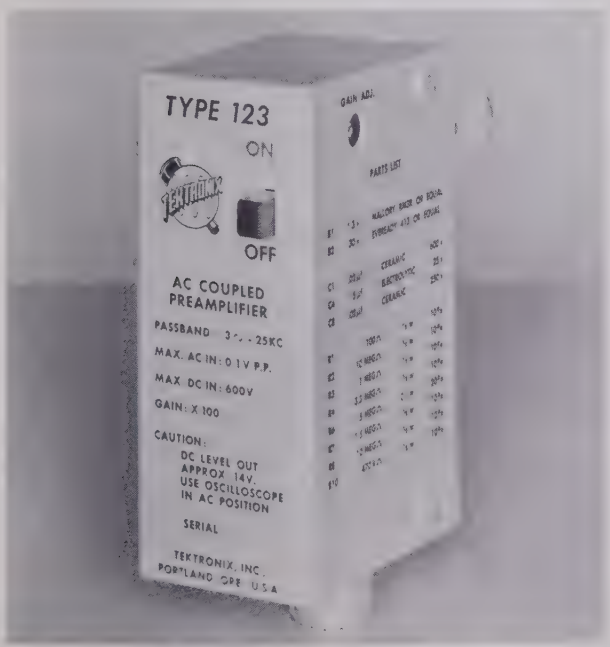
Frequency Response—Within 2% from 15 cycles to 6 kc. Within 3 db from 3 cycles to 25 kc.

Voltage Gain—100.

Hum-Free—Powered by miniature batteries.

Compact—$3\frac{5}{8}$" high, $1\frac{1}{2}$" wide, $2\frac{1}{4}$" deep.

Weight—10 ounces.



Type 122 Low-Level Preamplifier

Voltage Gain—1000.

Frequency Response—0.16 cycle to 40 kc maximum.

Rejection Ratio—80 to 100 db for inphase signals.

Noise Level—4 μv rms maximum.

Output Voltage—20 v maximum (peak-to-peak).

Input Impedance—Single ended: 10 megohms paralleled by approximately 50 pf. Differential: 20 megohms paralleled by approximately 50 pf.

Battery powered, if desired.

Type 125 Power Supply

Provides power for one to four Type 122 Amplifiers. Electronic voltage regulation improves drift stability of Type 122.

Rotan System

Designed to study rotation-associated phenomena in machinery, the Type 182B Angle-Encoding Transducer and Type 183B Rotation Analyzer adapt an oscilloscope to provide horizontal trace deflection proportional to angular displacement of a rotating shaft. Transduced data such as velocity, pressure, acceleration, or vibration, provides vertical trace deflection.

Three Marker Tracks—1-, 10-, and 360-degree intensity-marker and trigger pulses.

Output Voltages—Marker pulses not less than 10 v, trigger not less than 7 v.

Angular Velocity—Essentially zero to approximately 20,000 rpm.

Type 161 Pulse Generator

Variable-Amplitude—Positive or negative pulse from 0 to 50 v.

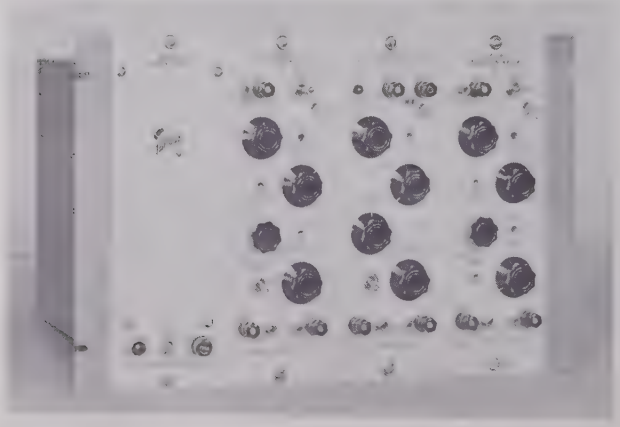
Positive Gate—50 v amplitude.

Output Characteristics—

Duration: calibrated, continuously variable, 10 μsec to 0.1 sec.

Delay: continuously variable, 0 to 100% of triggering sawtooth waveform.

Risetime: less than 0.5 μsec.



Type 162 Waveform Generator

Output Waveforms—Positive pulse, positive gate, and negative-going sawtooth.

Output Characteristics—

Repetition Rate: 0.1 c to 10 kc for recurrent operation.

Duration: pulse 10 μsec to 0.05 sec; gate and sawtooth, 100 μsec to 10 sec.

Amplitude—Pulse and gate, 50 v; sawtooth, +150 v to +20 v.

Type 163 Fast-Rise Pulse Generator

Variable-Amplitude Positive Pulse—0 to 25 v.

Fixed-Amplitude Positive Gate—25 v.

Output Characteristics—

Risetime: less than 0.2 μsec.

Duration: calibrated, continuously variable, 1 μsec to 10,000 μsec.

Delay—Continuously variable to 100% of triggering sawtooth duration.

Type 160A Power Supply

Large Load Capacity—Provides operating power for four to six 161, 162, 163 Units plus a 360 Indicator Unit.

Electronic Voltage Regulation.

Type 360 Indicator

Vertical Passband—DC to 500 kc.

Calibrated Vertical Attenuator Deflection Factor—0.05 v/div.

Waveform Requirements for Horizontal Deflection—50 v positive unblanking pulse, and a sawtooth of either polarity with amplitude from 110 to 150 v and extreme voltage limits at —90 v and +170 v.

Powered by a Type 160A, or Type 126 Power Supply.

Type 126 Power Supply

Provides operating power for one Type 161, 162, 163, or 360.

Electronic Voltage Regulation.

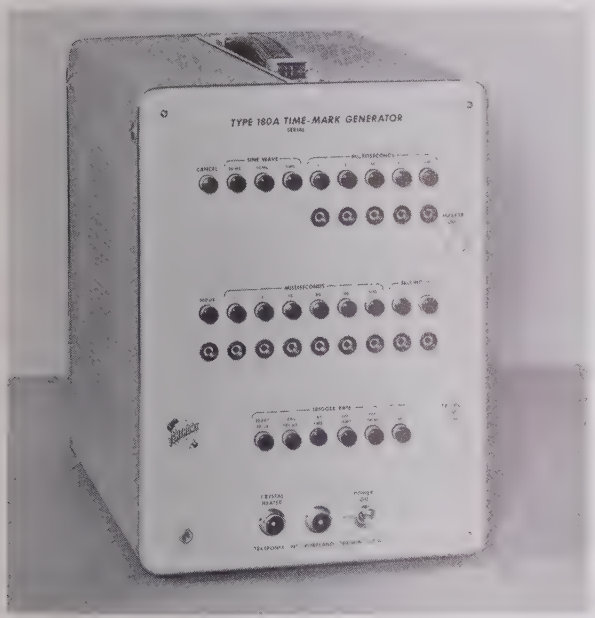
Type 180A Time-Mark Generator

Time-Marks—1, 5, 10, 50, 100, 500 μsec; 1, 5, 10, 100, 500 msec; 1, 5 seconds.

Three Sine-Wave Frequencies—5 mc, 10 mc, and 50 mc.

Six Trigger-Rate Frequencies—1, 10, 100 cycles and 1, 10, 100 kc.

Temperature-Stabilized Crystal—Provides stability of 3 ppm over 24-hour period.



Type 181 Time-Mark Generator

Time-Marks—1, 10, 100, 1000, and 10,000 μsec, plus 10-mc sine wave.

1-mc Crystal Controlled Oscillator is accurate within 0.03%.

Type 190B Constant-Amplitude Signal Generator

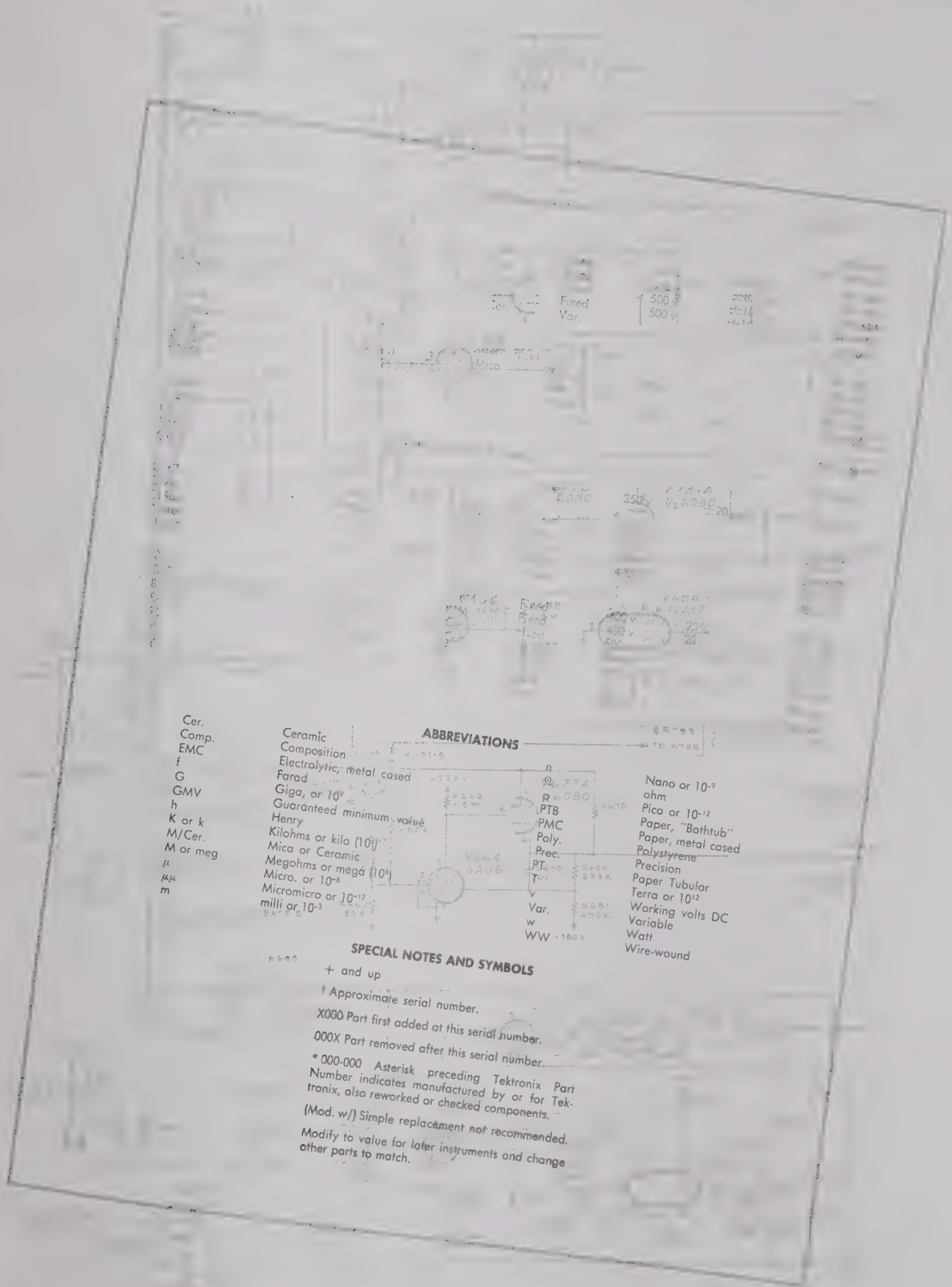
Output Frequency—350 kc to 50 mc, continuously variable, 50 kc reference signal.

Output Amplitude—40 mv to 10 v peak-to-peak, continuously adjustable.

Amplitude Variation—Less than ±2% from 50 kc to 30 mc; less than ±5% from 30 mc to 50 mc.

Harmonic Content—Typically less than 5%.

PARTS LIST *and* DIAGRAMS



ABBREVIATIONS

Cer.	Ceramic
Comp.	Composition
EMC	Electrolytic, metal cased
f	Farad
G	Giga, or 10^9
GMV	Guaranteed minimum value
h	Henry
K or k	Kilohms or kilo (10^3)
M/Cer.	Mica or Ceramic
M or meg	Megohms or mega (10^6)
μ	Micro. or 10^{-6}
μμ	Micromicro or 10^{-12}
m	milli or 10^{-3}
n	Nano or 10^{-9}
Ω	ohm
p	Pico or 10^{-12}
PTB	Paper, "Bathtub"
PMC	Paper, metal cased
Poly.	Polystyrene
Prec.	Precision
PT.	Paper Tubular
T	Terra or 10^{12}
V	Working volts DC
Var.	Variable
w	Watt
WW	Wire-wound

SPECIAL NOTES AND SYMBOLS

+ and up

† Approximate serial number.

X000 Part first added at this serial number.

000X Part removed after this serial number.

* 000-000 Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, also reworked or checked components.

(Mod. w/) Simple replacement not recommended. Modify to value for later instruments and change other parts to match.

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

TYPE RM561
MOD 5193
TENT. S/N 240

This instrument is modified by replacing conventional power cord to a right angle type. The purpose is to provide a cord that does not extend too far with instrument mounted in rack.

PARTS LIST

ADD	Cord, Power, 18 ga., 8ft, 3 wire, right angle female plug, straight male plug.	161-013

Type RM561
Mod. 3845 Eff S/N 240

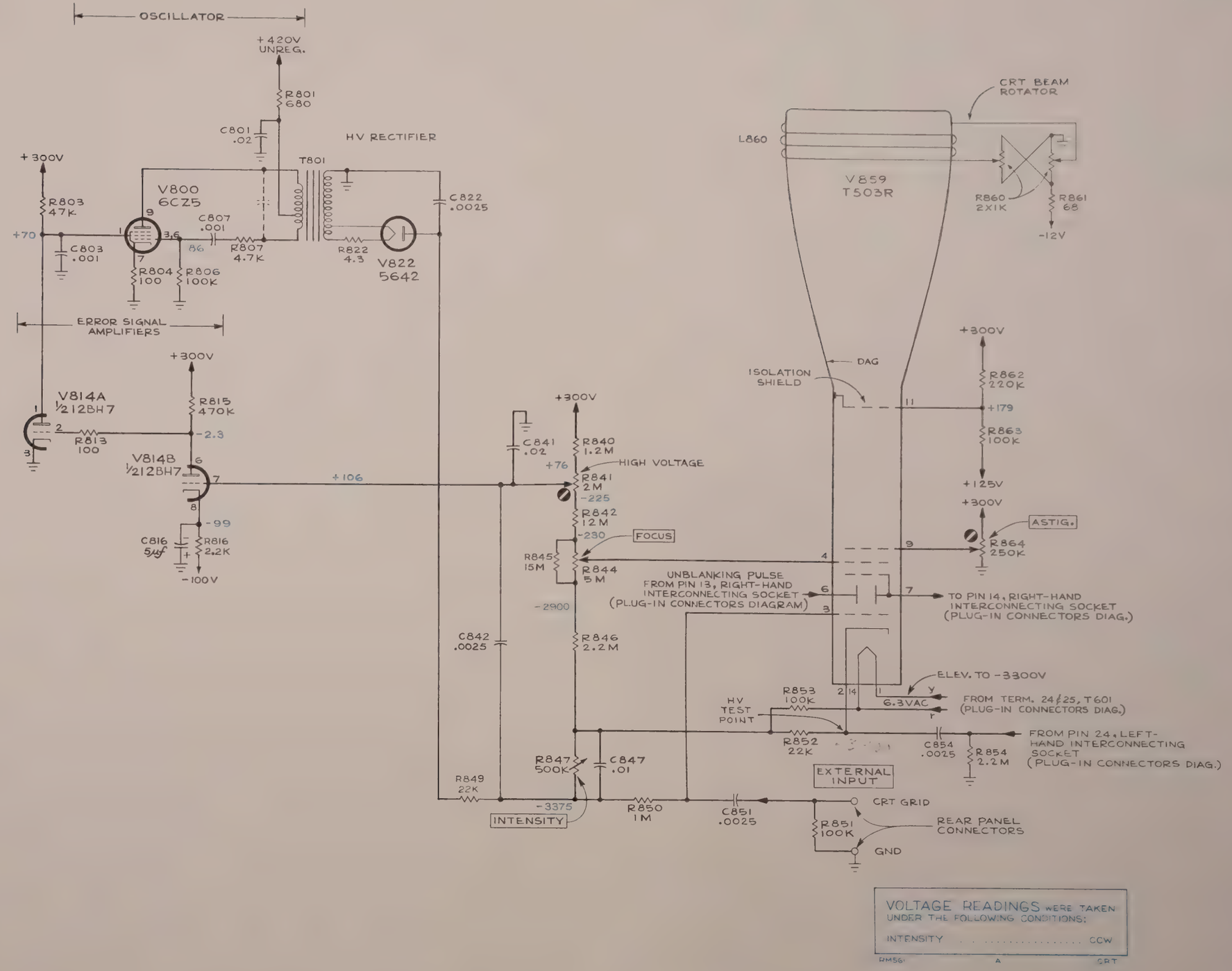
Add the following parts to the Mechanical Parts List.

BRACKET, PARALLAX Adj.	406-730
NUT, ADJ, 6-33 Tapped holes	214-207
RING, CLAMP	354-147
SCREW, 6-32 x 1" RHS	211-560
SCREW, 6-32 x 5/16 PHS	211-534
SCREW, 6-32 x 7/8 Skt Head	211-576
WASHER, 5/32 x 1/2 x 1/16	210-858

TYPE 561/RM561
Mod. 5114

This instrument has been modified to reduce possibility of failure of R842 on high voltage peaks.

R842	Change to	12M	2w	5%	5000v	310-595

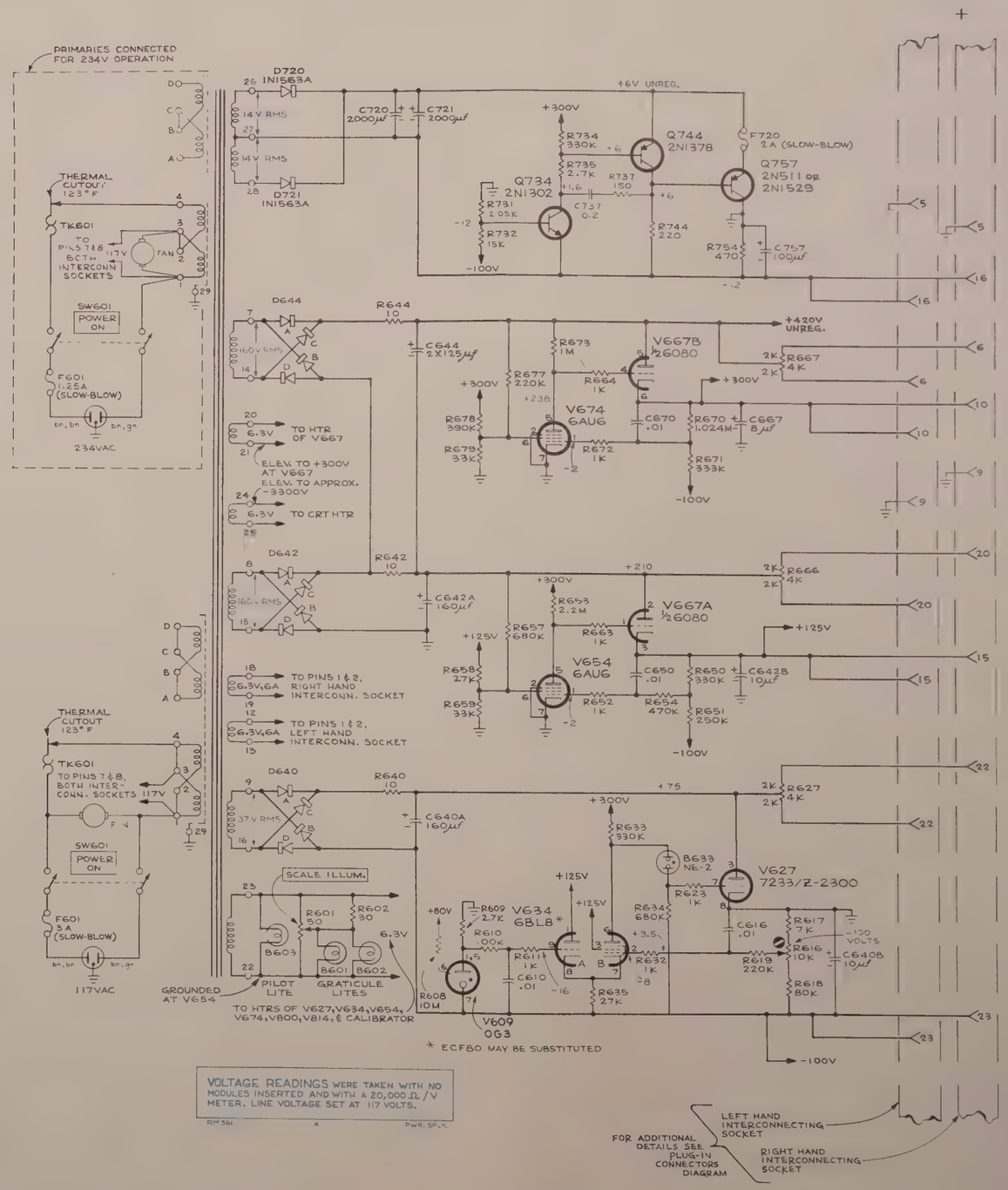


VOLTAGE READINGS WERE TAKEN UNDER THE FOLLOWING CONDITIONS:

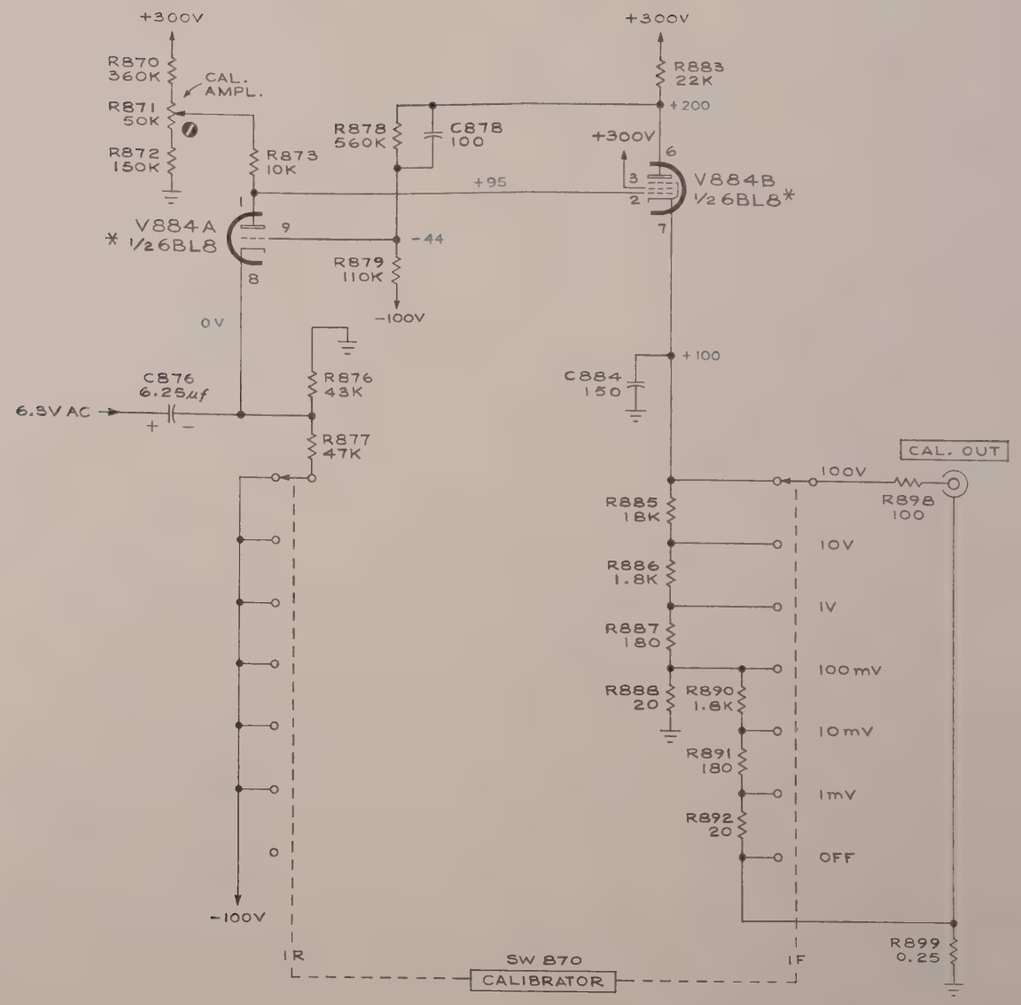
INTENSITY . . . . . CCW

RM561 A CRT

CRT CIRCUIT



TYPE RM561 OSCILLOSCOPE C CIRCUIT NUMBERS 600 THRU 759 2-7-62 POWER SUPPLY



VOLTAGE READINGS WERE TAKEN UNDER THE FOLLOWING CONDITIONS:

CALIBRATOR..... OFF

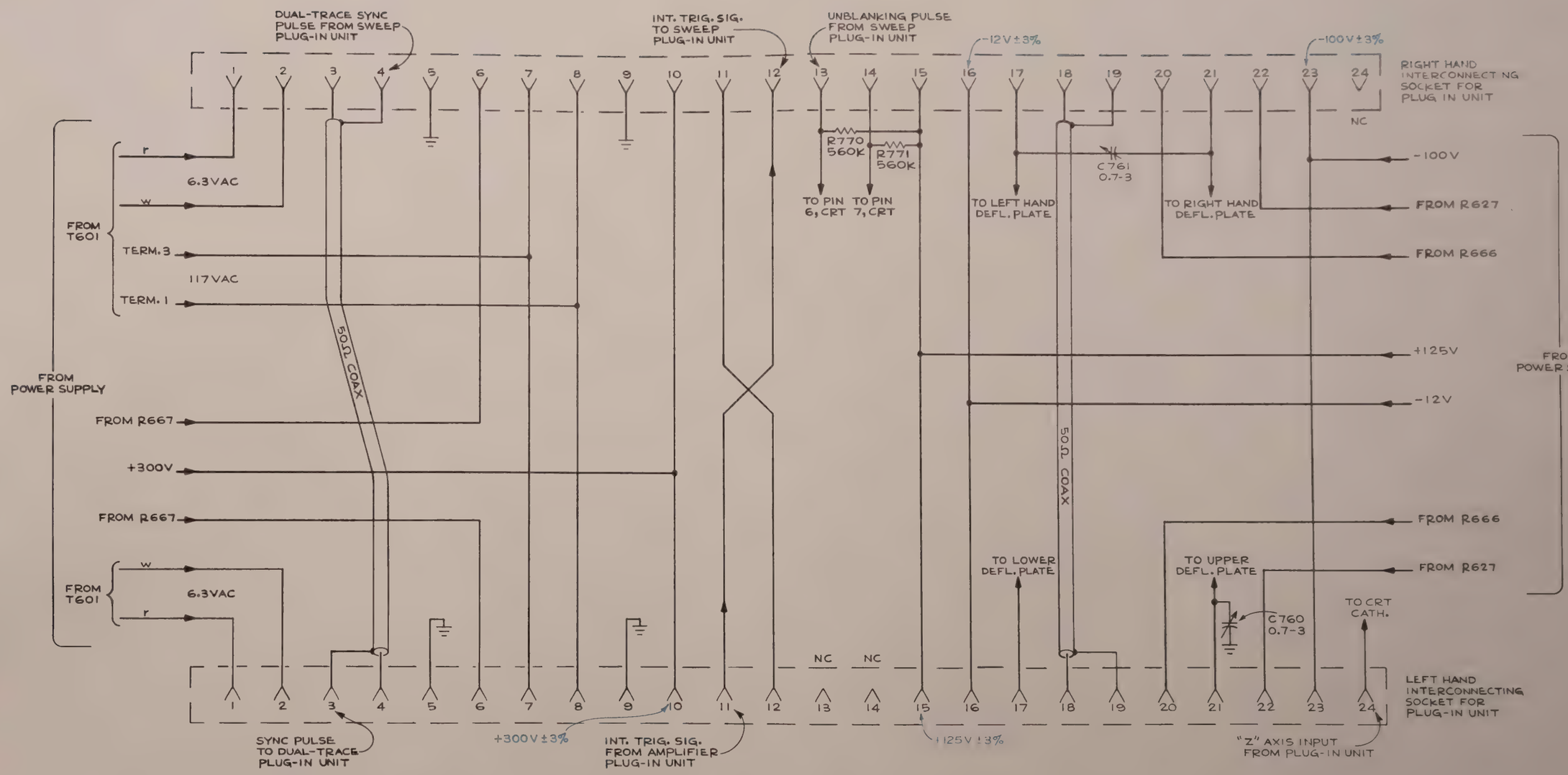
RM561 CAL.

* ECF80 MAY BE SUBSTITUTED

CIRCUIT NUMBERS 870 THRU 899

TYPE RM561 OSCILLOSCOPE A

MRH
4-13-61
CALIBRATOR



CIRCUIT NUMBERS 760 THRU 779

TYPE RM561 OSCILLOSCOPE

A

3-27-61 tp

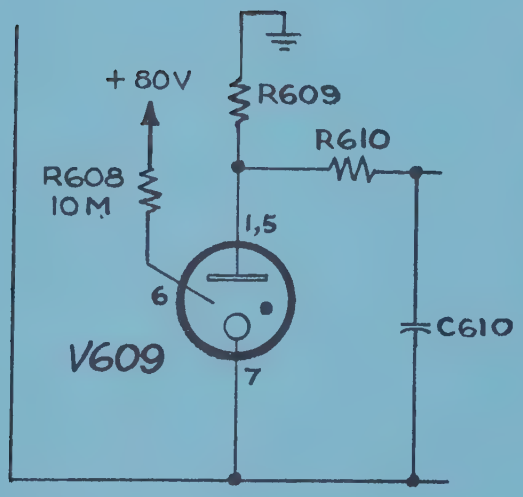
PLUG-IN CONNECTORS

TYPE 561, TENT. S/N 1280
TYPE RM561, TENT. S/N 260
MOD. 5200

This instrument has been modifed to reduce warm up time by lowering firing potential of V609.

PARTS LIST

R608	Add	10M	1/2w	10%	comp	302-106



PART. PWR. SPLY. DIAG.

TYPE 561/RM561
MOD 3854 Eff SN 1110
MOD 3855 Eff SN 220

R731	change to	2.05k	1/2w	Prec	1%	309-104
R732	change to	15k	1w	Prec	1%	310-115

TYPE 527 MOD 3846 TENT. S/N 310
TYPE 560 MOD 3847 TENT. S/N 360
TYPE 561 MOD 3848 TENT. S/N 260
TYPE RM561 MOD 3849 TENT. S/N 1245
TYPE RM527 MOD 3850 TENT. S/N 370

This instrument is modified to allow easier mounting of coax connector and insure a tighter connection.

PARTS LIST

TYPE 527

(1) Plate, rear panel	change to			*387-624
(6) Connector, chassis mount	change to	83	IRTY	131-064

TYPE 560

(1) Connector, chassis mount	change to	83	IRTY	131-064
(1) Plate, sub panel	change to			*387-621

TYPE 561

(1) Connector, chassis mount	change to	83	IRTY	131-054
(1) Plate, sub panel	change to			*387-621

TYPE RM561

(1) Connector, chassis mount	change to	83	IRTY	131-064
(1) Plate, sub panel	change to			*387-622

TYPE RM527

(6) Connector, chassis mount.	change to	83	IRTY	131-064
(1) Plate, rear panel	change to			*387-623

*New Tek made part.

PARTS LIST

Values are fixed unless marked Variable.

Bulbs

Ckt. No.	Tektronix Part Number	Description		S/N Range
B601	150-001	Incandescent, G. E, #47	Graticule Light	
B602	150-001	Incandescent, G. E. #47	Graticule Light	
B603	150-018	Incandescent, G. E. #12	Pilot Light	
B633	150-002	Neon, Type NE-2		

Capacitors

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors are as follows: (with exceptions)

3V - 50V = −10% - +250%
51V - 350V- = −10% - +100%
351V - 450V = −10% - +50%

C610	285-510	.01 μf	PTM		400 v	
C616	285-510	.01 μf	PTM		400 v	
C640A,B	290-060	160 x 10 μf	EMC		350 v	
C642A,B	290-061	160 x 10 μf	EMC		350 v	
C644	290-133	2 x 125 μf	EMC		350 v	
C650	285-510	.01 μf	PTM		400 v	
C667	290-002	8 μf	EMT		450 v	
C670	283-002	.01 μf	Discap		500 v	GMV
C720	290-087	2000 μf	EMC		30 v	
C721	290-087	2000 μf	EMC		30 v	
C737	283-026	.2 μf	Discap		25 v	
C757	290-015	100 μf	EMT		25 v	
C760	281-027	.7-3 μμf	Tub.	Var.		
C761	281-027	.7-3 μμf	Tub.	Var.		
C801	283-006	.02 μf	Discap		600 v	
C803	283-000	.001 μf	Discap		500 v	GMV
C807	285-501	.001 μf	PTM		600 v	
C816	290-149	5 μf	EMT		150 v	
C822	283-036	.0025 μf	Discap		6000 v	
C841	283-006	.02 μf	Discap		600 v	
C842	283-036	.0025 μf	Discap		6000 v	
C847	283-002	.01 μf	Discap		500 v	GMV
C851	283-036	.0025 μf	Discap		6000 v	
C854	283-036	.0025 μf	Discap		6000 v	
C876	290-025	6.25 μμf	EMT		300 v	
C878	281-523	100 μμf	Cer.		350 v	
C884	281-524	150 μμf	Cer.		500 v	

Diodes

D640A,B,C,D	(4) 152-047	1N2862 or equal
D642A,B,C,D	(4) 152-047	1N2862 or equal
D644A,B,C,D	(4) 152-047	1N2862 or equal
D720	152-035	1N1563A
D721	152-035	1N1563A

Fuses

Ckt. No.	Tektronix Part Number	Description	S/N Range
F601	159-005	3 Amp 3 AG Slo-Blo 117 V operation 50 & 60 cycle	
F720	159-023	2 Amp 3 AG Slo-Blo	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R601	311-055	50 Ω		Var.	WW	SCALE ILLUM.
R602	308-142	30 Ω	3 w		WW	5%
R609	302-272	2.7 k	½ w			
R610	302-104	100 k	½ w			
R611	302-102	1 k	½ w			
R616	311-015	10 k		Var.	WW	—100 Volts
R617	308-185	7 k	½ w		WW	1%
R618	308-186	80 k	½ w		WW	1%
R619	302-224	220 k	½ w			
R623	302-102	1 k	½ w			
R627	308-176	4 k	20 w		WW	5%
R632	302-102	1 k	½ w			
R633	302-334	330 k	½ w			
R634	302-684	680 k	½ w			
R635	302-273	27 k	½ w			
R640	304-100	10 Ω	1 w			
R642	304-100	10 Ω	1 w			
R644	304-100	10 Ω	1 w			
R650	309-101	330 k	½ w		Prec.	1%
R651	309-162	250 k	½ w		Prec.	1%
R652	302-102	1 k	½ w			
R653	302-225	2.2 meg	½ w			
R654	302-474	470 k	½ w			
R657	302-684	680 k	½ w			
R658	302-273	27 k	½ w			
R659	302-333	33 k	½ w			
R663	302-102	1 k	½ w			
R664	302-102	1 k	½ w			
R666	308-176	4 k	20 w		WW	5%
R667	308-176	4 k	20 w		WW	5%
R670	309-156	1.024 meg	½ w		Prec.	1%
R671	309-053	333 k	½ w		Prec.	1%
R672	302-102	1 k	½ w			
R673	302-105	1 meg	½ w			
R677	304-224	220 k	1 w			
R678	302-394	390 k	½ w			
R679	302-333	33 k	½ w			
R731	309-105	4.21 k	½ w		Prec.	1%
R732	309-037	31.1 k	½ w		Prec.	1%
R734	302-334	330 k	½ w			

Resistors *(continued)*

Ckt. No.	Tektronix Part Number		Description			S/N Range
R735	302-272	2.7 k	½ w			
R737	302-151	150 Ω	½ w			
R744	306-221	220 Ω	2 w			
R754	302-471	470 Ω	½ w			
R770	302-564	560 k	½ w			
R771	302-564	560 k	½ w			
R801	306-681	680 Ω	2 w			
R803	306-473	47 k	2 w			
R804	302-101	100 Ω	½ w			
R806	302-104	100 k	½ w			
R807	302-472	4.7 k	½ w			
R813	302-101	100 Ω	½ w			
R815	302-474	470 k	½ w			
R816	302-222	2.2 k	½ w			
R822	307-056	4.3 Ω	½ w			5%
R840	301-125	1.2 meg	½ w			5%
R841	311-227	2 meg		Var.		High Voltage
R842	310-568	12 meg	2 w		Prec.	5%
R844	311-254	5 meg		Var.		FOCUS
R845	304-156	15 meg	1 w			
R846	304-225	2.2 meg	1 w			
R847	311-253	500 k		Var.		INTENSITY
R849	302-223	22 k	½ w			
R850	302-105	1 meg	½ w			
R851	302-104	100 k	½ w			
R852	302-223	22 k	½ w			
R853	302-104	100 k	½ w			
R854	302-225	2.2 meg	½ w			
R860	311-007	2 x 1 k		Var.		CRT Beam Rotator
R861	302-680	68 Ω	½ w			
R862	302-224	220 k	½ w			
R863	302-104	100 k	½ w			
R864	311-206	250 k		Var.		ASTIG.
R870	301-364	360 k	½ w			5%
R871	311-224	50 k		Var.		Cal Ampl.
R872	301-154	150 k	½ w			5%
R873	302-103	10 k	½ w			
R876	301-433	43 k	½ w			5%
R877	301-473	47 k	½ w			5%
R878	301-564	560 k	½ w			5%
R879	301-114	110 k	½ w			5%
R883	305-223	22 k	2 w			5%
R885	310-066	18 k	1 w		Prec.	1%
R886	309-030	1.8 k	½ w		Prec.	1%
R887	309-072	180 Ω	½ w		Prec.	1%
R888	309-064	20 Ω	½ w		Prec.	1%
R890	309-030	1.8 k	½ w		Prec.	1%
R891	309-072	180 Ω	½ w		Prec.	1%
R892	309-064	20 Ω	½ w		Prec.	1%
R898	302-101	100 Ω	½ w			
R899	*308-090	.25 Ω	1 w		WW	

Switches

Ckt. No.	Tektronix Part Number Unwired	Wired	Description	S/N Range
SW601	260-014		POWER ON Toggle	
SW870	*260-394	*262-415	CALIBRATOR Rotary	

Thermal Cutout

TK601	260-246	Thermal Cutout 123°

Transformers

T601	*120-224	L.V. Power
T801	*120-225	H.V. Power

Transistors

Q734	151-040	2N1302
Q744	151-042	2N1378
Q757	151-046	2N1529

Electron Tubes

V609	154-291	OG3
V627	154-307	7233/Z2300
V634	154-278	6BL8
V654	154-022	6AU6
V667	154-056	6080
V674	154-022	6AU6
V800	154-167	6CZ5
V814	154-046	12BH7
V822	154-051	5642
V859	*154-320	T503R CRT P-2 Standard Phosphor
V884	154-278	6BL8

Type RM561
Mechanical Parts List

	Tektronix Part Number
ADAPTOR, 3 WIRE TO 2 WIRE	103-013
BRACKET, CRT SHIELD, RIGHT	406-710
BRACKET, CRT SHIELD, LEFT	406-711
BRACKET, PLUG-IN	406-716
BUSHING, $\frac{3}{8}$-32 x $\frac{9}{16}$ x .412	358-010
BUSHING, INSULATOR, COAX CONN.	358-097
CABLE, HARNESS, CHASSIS	179-541
CABLE, HARNESS, AMPHENOL	179-560
CAP, POT 1" POLY.	200-247
CHASSIS, FRONT	441-389
CHASSIS, REAR	441-390
CLAMP, CABLE, $\frac{5}{16}$ PLASTIC	343-004
CLAMP, CRT	343-078
CONNECTOR, CHASSIS MTD., 1 CONTACT, FEMALE	131-081
CONNECTOR, CHASSIS MTD., 24 CONTACT, FEMALE	131-148
CONNECTOR, CHASSIS MTD., 3 WIRE MOTOR BASE, MALE	131-150
CORD, POWER	161-010
COVER, GRATICULE	200-272
CUSHION, RUBBER	348-041
FASTENER, PAWL RIGHT	214-052
FASTENER, PAWL LEFT	214-053
GRATICULE, .125 x 4$\frac{13}{16}$ x 5$\frac{5}{16}$	331-076
GROMMET, RUBBER $\frac{1}{2}$	348-005
GROMMET, RUBBER $\frac{3}{4}$	348-006
GUIDE, CLIPS FOR "MUFFIN FAN"	351-046
GUIDE, RAIL TRACK	351-047
HANDLE, DRAWER	367-008
HOLDER, LITTLEFUSE	352-014
HOLDER, NYLON FOR COIL FORM $\frac{3}{16}$ x $\frac{3}{4}$ TAPPED 4-40	352-015
HOLDER, FUSE, SINGLE	352-031
INSERT, GRATICULE LIGHT, RED	377-064
KNOB, SMALL BLACK, $\frac{1}{4}$ HOLE PART WAY	366-044
KNOB, SMALL GREY	366-083
KNOB, SMALL METAL	366-109

	Tektronix Part Number
LOCKWASHER, INT. #4	210-004
LOCKWASHER, INT. #6	210-006
LOCKWASHER, INT. #10	210-010
LOCKWASHER, INT., POT, 3/8 x 1/2	210-012
LOCKWASHER, INT., 3/8 x 11/16	210-013
LUG, SOLDER, SE4	210-201
LUG, SOLDER, POT, PLAIN 3/8	210-207
LUG, SOLDER, 1/4"	210-223
LUG, SOLDER GROUND MIL'D STL.	210-241
NUT, HEX 4-40 x 3/16	210-406
NUT, HEX 6-32 x 1/4	210-407
NUT, HEX 3/8-32 x 1/2	210-413
NUT, HEX 15/32-35 x 9/16	210-414
NUT, SPEED, #6	210-434
NUT, KEPS, 6-32 x 5/16	210-457
NUT, KEPS, 8-32 x 11/32	210-458
NUT, HEX, 8-32 x 1/2 x 23/64 25W RESISTOR MTG.	210-462
NUT, HEX, 1/4-32 x 3/8 x 3/32	210-465
NUT, SWITCH 12-SIDED	210-473
NUT, HEX, 3/8-32 x 1/2 x 11/16	210-494
NUT, SQUARE, 10-32 x 3/8	210-501
PANEL, FRONT	333-665
PLATE, SIDE RIGHT	387-446
PLATE, SIDE LEFT	387-447
PLATE, SUBPANEL, FRONT	387-448
PLATE, RIGHT SIDE COVER	387-449
PLATE, LEFT SIDE COVER	387-450
PLATE, REAR	387-451
PLATE, DUST COVER	387-452
PLATE, RECTIFIER BRACKET	387-453
PLUG, BANANA, MALE, TWIN	134-012
RING, LOCKING SWITCH	354-055
ROD, NYLON, 5/16 x 3/4 TAPPED 6-32 THRU	385-013
ROD, NYLON, 5/16 x 5/8, TAPPED 6-32 THRU W/#18 HOLE	385-033
ROD, NYLON, 5/16 x 1 3/4, TAPPED 6-32 BOTH ENDS	385-060
ROD, DELRIN, 5/16 x 1 9/16 W/MTG. HOLE ONE END & FOUR #44 HOLES	385-138

	Tektronix Part Number
SCREEN, GRILLE FOR "MUFFIN FAN"	378-761
SCREW, 4-40 x 1/2 BHS	211-014
SCREW, 4-40 x 1/4 FHS	211-023
SCREW, 4-40 x 5/16 PAN HS W/LOCKWASHER	211-033
SCREW, 2-56 x 5/16 RHS, PHILLIPS	211-057
SCREW, 6-32 x 1/4 BHS	211-504
SCREW, 6-32 x 5/16 BHS	211-507
SCREW, 6-32 x 3/8 BHS	211-510
SCREW, 6-32 x 5/16 PHS W/LOCKWASHER	211-534
SCREW, 6-32 x 5/16 FHS, 100°, CSK, PHILLIPS	211-538
SCREW, 6-32 x 1/4 FHS, 100°, CSK, PHILLIPS	211-541
SCREW, 6-32 x 5/16 RHS	211-543
SCREW, 6-32 x 3/8 FHS, 100°, CSK, PHILLIPS	211-559
SCREW, 6-32 x 1/4 TRUSS HS, PHILLIPS	211-565
SCREW, 8-32 x 1/4 BHS	212-001
SCREW, 8-32 x 1/4 FHS, 100°	212-002
SCREW, 8-32 x 5/16 BHS	212-004
SCREW, 8-32 x 3/8 BHS	212-023
SCREW, 8-32 x 1 3/4 FIL HS	212-037
SCREW, 8-32 x 3/8 FHS, 100°, PHILLIPS	212-040
SCREW, 8-32 x 5/16 FHS, PHILLIPS	212-070
SCREW, 10-32 x 1/2 BHS	212-508
SCREW, 10-32 x 1/2 OHS	212-512
SCREW, 10-32 x 7/8 RHS	212-548
SCREW, 12-24 x 1/2 OHS	212-561
SCREW, THREAD CUTTING, 4-40 x 1/4 PHS, PHILLIPS	213-035
SCREW, THREAD CUTTING, 6-32 x 3/8 TRUSS HS, PHILLIPS	213-041
SCREW, THREAD CUTTING, 5-32 x 3/16 PAN HS, PHILLIPS	213-044
SCREW, THREAD FORMING, 4-40 x 1/4 PHS, PHILLIPS	213-088
SHIELD, TUBE, 1 1/32 W/SPRING, 1 15/16 HI	337-008
SHIELD, CRT	337-418
SHIELD, F & I, LEFT SIDE	337-451
SHIELD, F & I, RIGHT SIDE	337-452
SHIELD, HIGH VOLTAGE, POWER	337-455
SOCKET, STM7G	136-008
SOCKET, STM8	136-013

CALIBRATION VOID